

# *Contractor's Report to the Board*

## *Best Management Practices For Electronic Waste*

*April 2004*

*Produced under contract by:*

*Santa Clara County Department of  
Environmental Health  
San Jose, California*



*Zero Waste—You Make It Happen!*

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# Executive Summary

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Electronic waste (e-waste) is the most rapidly growing segment of the municipal waste stream. E-waste is a general category of electronic products including broken or obsolete televisions, computer monitors, central processing units (CPU), cordless and cell phones, cash registers, videocassette recorders, cell phones, copiers and printers, stereos and speakers, microwaves, x-ray machines, and some scientific equipment. These products may contain toxic materials such as lead, barium, mercury, and cadmium that require proper management as well as valuable resources that should be recovered.

Agencies that handle, transport, recycle, or dispose of e-waste need specific guidance to assure that the growing waste flow of end-of-life electronic products is managed in a way that protects public health and the environment and conserves resources. The volume, weight, storage needs, and costs of e-waste management present special challenges, as compared to managing solid waste or household hazardous waste.

In March and April 2002, the CIWMB administered a web-based survey to determine assistance needs for Cathode Ray Tube (CRT) collection and recycling programs. The survey was directed to local government agencies responsible for implementing e-waste management programs and for environmental compliance programs including local enforcement agencies, certified unified program agencies, permitting and inspection, recycling coordinators, solid waste facilities, and household hazardous waste programs. A copy of this survey and summary of the results are attached to this report as Appendices A and B.

The survey asked respondents to indicate their level of concern and to comment about issues including regulations, illegal dumping, collection points, storage, transportation, education, procurement, end markets, environmental safeguards, and finance. Of these issues, the top concerns from local government were finance, end markets, and environmental safeguards.

Best management practices (BMP) were the most frequently requested guidance materials by all agencies. Best management practices are guidelines for selecting the most environmentally desired methods for managing a waste stream, following the waste management hierarchy of reuse of electronic equipment and components, recycling equipment and components for material recovery, management for energy recovery, and finally, disposal of materials.

The BMP project involved assessing local government concerns and collecting available information on proper management of e-waste through research of CIWMB resources. The project also included nationally recognized organizations involved in e-waste management. The BMP guide for e-waste management was designed to assist local government in the considerations and decisions needed for program planning and implementation, with emphasis on environmentally sound management and due diligence to ensure proper recycling.

Agencies operating e-waste collection programs need to be concerned about their waste generator liability. E-waste is hazardous waste if it is not properly managed, and as with any hazardous waste, a local jurisdiction has CERCLA (Comprehensive Emergency Response, Liability and Compensation Act [Superfund]) liability. Agencies should follow the materials resulting from e-waste recycling to their end destination and ensure that all materials and components are properly recycled.

In the CIWMB survey, local government requested e-waste recycler certification as an assurance that the companies are meeting standards. Several voluntary Environmental Management Systems (EMS) programs certify that a business is meeting established standards for business

practices, regulatory compliance, and sound environmental performance. Third-party independent auditors certify compliance with program standards.

An EMS program to certify e-waste recyclers would augment regulatory compliance inspections and provide local government a level of assurance of proper e-waste management. Audits to agreed-upon standards would have credibility among the base of customers, and they would provide a level playing field for e-waste recyclers.

Finally, development of a system for local government to share environmental compliance information would simplify the due diligence process for local government. Statewide e-waste contract models that could be used by local government offer consistency in waste handling and disposal requirements as well as a centralized compliance monitoring opportunity. Alternatively, other methods of sharing of audit results could be accomplished through a database available to e-waste collectors. If an EMS certification system was developed for e-waste recyclers, independent auditors could supply information to prospective service users.

The best management practices for e-waste are changing on a continual basis and will evolve over time. The e-waste best management guide represents a snapshot to assist local government with implementing new programs, and it needs to be continually updated based on lessons learned.

## Background Information

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Although electronic waste (e-waste) seems to have only recently become a problem, this issue has been building since the electronic products and computers were first manufactured. Electronic waste includes broken or obsolete televisions, computer monitors, central processing units, phones, videocassette recorders, copiers and printers, stereos and speakers, microwaves, and other electronic equipment. As a general category, e-waste may contain significant amounts of heavy metals and other hazardous materials.

Since March 2001, when the Department of Toxic Substances Control (DTSC) reaffirmed that cathode ray tubes (CRT) are hazardous waste, local government has become a default collector for these wastes that can no longer be landfilled. CRTs are categorized as universal waste, which offers streamlined management requirements for commonly produced wastes that pose a low risk to human health and the environment.

The DTSC Universal Waste regulations approved on February 3, 2003, gave California households a three-year exemption from the standards for managing all hazardous consumer electronic devices as universal waste. This exemption allows for temporary disposal of consumer electronic devices in household trash, allowing local government and other collectors time to build infrastructure and capacity for handling universal waste streams. (CRTs are not included in this exemption, and they must be managed as universal waste now.)

Beginning on February 9, 2006, the list of electronic products that will need special management as universal waste will grow astronomically. Preliminary tests show that many products with a circuit board or battery will be classified as hazardous due to their toxicity.

Local government has a primary role in the diversion of electronic wastes from landfills. In order to provide cost-effective and convenient service to residents, jurisdictions will want to utilize existing infrastructure resources. E-waste collection will probably be delegated to household hazardous waste programs, landfills or transfer stations, recycling centers, or solid waste haulers. While universal waste regulations eliminate some hazardous waste regulatory requirements for

the collection and transportation of waste electronics, when e-waste reaches the final destination facility, it must be managed as hazardous waste.

If e-waste is not properly recycled, the generator or e-waste collection program can become financially responsible for Superfund cleanup under provisions of the CERCLA. Scrap metal dealers were given new liability exemptions in the 1999 Superfund Recycling Equity Act. If e-waste from your program is sold to a scrap metal dealer and somehow finds its way to a Superfund site, the liability burden can go back to local government.

Best management practices are guidelines for selecting the most environmentally desired methods for managing a waste stream. E-waste collection programs need guidelines to assure that products are managed in a way that protects public health and the environment and conserves valuable resources. End-of-life electronic equipment contains valuable resources such as precious metals, engineered plastics, glass, and other materials, all of which require energy to manufacture. If these resources are not recovered, additional pollution will be generated to manufacture new products out of virgin materials.

## Discussion of Problem

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Electronic wastes comprise from 2 to 5 percent of the municipal solid waste stream. This rapidly growing segment of our waste is one of substantial concern because of its hazardous and toxic materials content. Rapid technological advances and lower product prices for more powerful machines are contributing to shorter product life spans and frequent replacement. Electronic equipment quickly loses its resale value. Yet, consumers are likely to store their old electronics, believing that it still has value. According to a 1999 study by the National Safety Council's Environmental Health Center, three-quarters of all of the computers sold in the U.S. remain stockpiled in a garage, closet, or storage space.

End markets are always a recycling challenge. The recycled material must have enough value to make it worthwhile for the cost of collecting, transporting, processing, and marketing. The costs of recycling CRTs exceed their commodity value. Markets for leaded CRT glass and plastics are limited. With consumer electronics, only metals have established, cost-effective processes in place. The infrastructure for recycling other materials contained in electronics is still being built.

To date, many electronics dismantlers and scrap metal dealers have principally focused on large sources of electronic scrap and used equipment that can be obtained from manufacturing, government, and commercial sources. Recycling of business electronic waste is profitable compared to e-waste from residential collections. The cost of collection and transport of used PCs from commercial sources is significantly less than for the recovery of similar equipment from the residential sector. While salvage value from computer components and metals recovery may offset some collection and recycling costs, residential e-waste collection programs will probably not result in any net value for the program sponsor.

Local governments need financial assistance with the costs of e-waste management. Governing boards are reluctant to increase fees to residents. E-waste recycling costs cannot be absorbed in current refuse, recycling, and household hazardous waste budgets. Rural counties have an added disadvantage due to lack of economies of scale, long transportation distances, and vulnerability to illegal dumping.



# Project Objectives

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The primary objective of this project is to develop guidance tools for local governments and others to ensure that e-waste is managed in a way that protects public health and the environment while conserving valuable resources.

The information garnered through completion of this project will serve to inform the Board members, local government staff, and the general public on how to properly manage e-waste.

## Discussion of Survey Results and Project

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In April and May 2002, the California Integrated Waste Management Board (CIWMB) administered a survey to local government to assess needs for Cathode Ray Tube (CRT) collection and recycling programs. The survey was directed to local government agencies responsible for implementing e-waste management programs and for environmental compliance programs including local enforcement agencies, certified unified program agencies, permitting and inspection, recycling coordinators, solid waste facilities, and household hazardous waste programs. A copy of this survey and findings of the results are attached as Appendices A and B.

The primary objective of the survey was to determine the various target audience needs concerning management of e-waste. The survey asked respondents to indicate their level of concern about issues including regulations, illegal dumping, collection points, storage, transportation, education, procurement, end markets, environmental safeguards, and finance. Of these issues, the top concerns from local government were finance, end markets, and environmental safeguards.

### **Finance**

The costs of CRT recycling programs cannot be absorbed into solid waste or household hazardous waste programs. Increasing taxes or fees is not an acceptable solution due to the current fiscal constraints and ratepayer fatigue. Often, the final users of electronic equipment have limited financial means and may be unable or unwilling to pay a disposal fee for recycling. Of the agencies that charge for recycling of CRTs, most stated that they were not recovering the actual costs of the programs.

The survey results showed that most government respondents saw a correlation between end-of-life fees and illegal disposal. Rural areas are particularly vulnerable to illegal dumping. CRTs are being hidden in loads of trash and dumped along county roadways; in creek beds, open fields, and alleys; and left at thrift stores and television repair shops.

### **End Markets**

A need exists for more markets for e-waste materials, especially local (West Coast) markets. Collection facilities want to be notified of new end possessing facilities as they open.

End markets were of great concern to local government respondents. The environmental compliance of recyclers and their downstream processors is difficult to monitor because the materials often leave the state and the country. While markets for the products resulting from e-waste are overseas, respondents are uncomfortable with materials being sent to countries with less stringent health, safety, and environmental laws. Many believe that original equipment manufacturers (OEM) should be required to take back their used products. If the manufacturers were responsible for the end markets, they would design the CRTs to be more readily recycled.

## ***Environmental Safeguards***

E-waste program implementers expressed a need for a mechanism to ensure that recyclers are handling materials in an environmentally responsible manner. Requests were made for access to environmental compliance reports and for a certification process for universal waste recyclers. Local governments want tools to assist them in selecting vendors, and they expressed concern for hazardous waste generator liability for e-waste from their programs.

The survey also showed a concern for the long-term liability associated with smelters and the desire to see development of a strong glass-to-glass recycling capacity. The CIWMB needs to continue working with industry to develop end markets for CRTs and other e-waste components. End markets should be aggressively promoted for end products including glass, plastic, and metals.

## ***Requests for Assistance***

Respondents were also given an opportunity to make specific assistance requests from the CIWMB. Best management practices were the most frequently requested guidance materials by all agencies. Generally, e-waste program implementers wanted technical assistance, while compliance agencies more frequently requested training and advisories.

All local government groups placed priority on CIWMB assistance with public education. Many respondents believed that a statewide education program would be advantageous. Local governments want assistance in development of public education materials and funds to implement education programs.

## ***Best Management Practices Research***

The best available information on proper management of e-waste was collected through research of CIWMB resources, as well as those of nationally recognized organizations involved in e-waste management. References used in the preparation of the best management practices are included in the bibliography.

A step-by-step guide for e-waste management was designed to assist local government in the considerations and decisions needed for program planning and implementation, with emphasis on environmentally sound management and due diligence to ensure that all materials and components are properly recycled. The best management practices for e-waste are changing on a continual basis and will evolve over time. This guide (Appendix C) represents a snapshot to assist local government with implementing new programs. The guide needs to be updated based on lessons learned.

## **Findings and Conclusions**

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Local government will play a lead role in the diversion of hazardous electronic wastes from landfills. In order to provide cost-effective and convenient service to residents, jurisdictions will need to utilize existing infrastructure resources. E-waste collection will probably be delegated to household hazardous waste programs, landfills or transfer stations, recycling centers, or solid waste haulers. The costs of collection, transportation, and recycling of electronic waste cannot be absorbed into solid waste and household hazardous waste budgets.

CRT recycling/disposal costs should be paid at the point of purchase, not at the point of disposal. The final users of CRTs often have few financial resources and limited ability to pay for disposal or other processing. If the cost were built into the purchase of new CRTs, it would encourage proper recycling.

According to the e-waste survey, local governments want the CIWMB to advocate on their behalf for extended producer responsibility that would shift end-of life management responsibility from government-sponsored programs to manufacturers and retailers. Manufacturer take-back of electronics would provide industry with an incentive to reduce the toxicity of products and to design products that are more easily recycled. Manufacturers and retailers also have a major role in educating the public by providing point-of-sale disposal information and product labels indicating which electronics will become hazardous waste.

Long-term liability for e-waste needs to be a primary concern for public agencies, and costs for recycling e-waste cannot be the only consideration. For the contractor and all proposed subcontractors, as well as companies responsible for dismantling, sale, reuse, and recycling of materials, government agencies should be asking about regulatory compliance, insurance and indemnification, closure plans and financial assurance, and recent certified financial audits.

Certificates of recycling/destruction are not regulated documents and are only as good as the information they contain. Although a certificate does not relieve cradle-to-grave liability, it can help protect your organization. This documentation provides an audit trail that traces e-waste from the collection site to the final processing facilities, including the dates of processing and the management methods utilized.

Environmental management systems (EMS) are voluntary programs that set standards for business practices, regulatory compliance, and sound environmental performance. Third-party independent auditors certify that recyclers are following agreed-upon standards throughout their management processes. An EMS program to certify e-waste recyclers would augment regulatory compliance inspections.

Voluntary registration and auditing would benefit both local government and recyclers. Third-party environmental audits are a valuable tool for businesses to help minimize liability, avoid compliance costs associated with new projects, and find opportunities for improved operating practices. An EMS certification process would provide local government with assurance of proper e-waste management. Audits to agreed-upon standards would have credibility across the base of customers and provide a level playing field for e-waste recyclers.

Finally, development of a system for local government to share environmental compliance information would simplify the due diligence process for local government. Statewide e-waste contract models that could be used by local government offer consistency in waste handling and disposal requirements as well as a centralized compliance monitoring opportunity. Alternatively, other methods of sharing audit results could be accomplished through a database available to e-waste collectors. If an EMS certification system was developed for e-waste recyclers, independent auditors could supply information to prospective service users.



**Appendix A**  
**CIWMB Survey on CRT Management**  
**Issues—Survey Questions**

Once you have completed this survey, be sure to select the SUBMIT button at the bottom of the page to forward all of your comments to the California Integrated Waste Management Board for their consideration.

### **General Information**

Check all boxes that apply to you:

<input type="checkbox"/> LEA	LEA	<input type="checkbox"/> CUPA	CUPA	<input type="checkbox"/> RC	Recycling Coordinator	<input type="checkbox"/> PII	Permitting and Inspection Inspector
<input type="checkbox"/> SWF	Solid Waste Facility			<input type="checkbox"/> HHW	Household Hazardous Waste (HHW) Facility		
<input type="checkbox"/> Other	Other						

Please complete the following information:

Your name:

Phone number:

E-mail address:

#### **For HHW and Solid Waste Facilities:**

Facility or site name:

SWIS number (if know/applicable):

Street address:

City:

Zip code:

## ***Issues Regarding CRTs***

For each issue listed below, note your level of concern on the left and provide any examples, specific cases, or questions on the right. If applicable, please indicate the affected site or facility.

### ***Regulations***

1	No current concern	
2	Low priority	
3	Medium priority	
4	High priority	

### ***Illegal Dumping***

1	No current concern	
2	Low priority	
3	Medium priority	
4	High priority	

### ***Collection Points***

1	No current concern	
2	Low priority	
3	Medium priority	
4	High priority	

### ***Storage/Stockpiling***

1	No current concern	
2	Low priority	
3	Medium priority	
4	High priority	

### ***Transportation***

1	No current concern	
2	Low priority	
3	Medium priority	
4	High priority	

**Public Education**

1	No current concern
2	Low priority
3	Medium priority
4	High priority

--

**Processing**

1	No current concern
2	Low priority
3	Medium priority
4	High priority

--

**End Markets**

1	No current concern
2	Low priority
3	Medium priority
4	High priority

--

**Environmental Safeguards**

1	No current concern
2	Low priority
3	Medium priority
4	High priority

--

**Financing**

1	No current concern
2	Low priority
3	Medium priority
4	High priority

--



**Other**

1	No current concern	
2	Low priority	
3	Medium priority	
4	High priority	

**Areas of Requested Assistance**

Please check the boxes for each area where you would like to see assistance from CIWMB. You can include additional details in the comment box provided below.

Yes	Guidance material	Yes	Website information availability
Yes	Technical assistance	Yes	Training
Yes	Fact sheets	Yes	Public education needs
Yes	Advisory	Yes	Funding
Yes	Best management practices information	Yes	Other
Yes	Other		
Yes	Statutory updates, clarification, and proposed changes		
Yes	Regulatory updates, clarification, and proposed changes		

**Comments**

--

**Optional Survey Category**

Include any comments, concerns or questions on universal wastes other than CRTs. Please specify the type of universal wastes (i.e. aerosol cans, fluorescent tubes, batteries, mercury switches).

--

To complete this survey, select the submit button below. For additional assistance, please contact Janet Munger at (916) 341-6382.

Submit

**Appendix B**  
**Issues Regarding CRT Management**  
**Summary of CIWMB Survey Results**

# Summary of Major Findings

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## **Background**

In April and May 2002, the California Integrated Waste Management Board (CIWMB) administered a survey to local government to assess needs for cathode ray tube (CRT) collection and recycling programs. The survey was directed both at local government agencies responsible for implementing E-waste management programs and at those managing environmental compliance programs. CIWMB staff compiled results of this survey. Under a contract for development of best management practices and public education materials for E-waste, these results have been summarized to determine priorities for assistance needs of local government.

## **Research Highlights**

In brief, when CRTs were determined to be hazardous and banned from landfill disposal, local government became the default agency for both collection and cleanup for illegally dumped CRTs. Local government is faced with uncertain end markets, high transportation and collection costs, and lack of funding to manage these wastes.

- The financing of electronic collection events and permanent collection facilities is a burden for local jurisdictions. E-waste programs compete for dollars with household hazardous waste (HHW) and recycling programs.
- Illegal dumping of e-waste is on the rise. Local government reports indicate a correlation between CRT disposal charges to residents and the incidence of illegal dumping.
- Local government, by default, is becoming responsible for electronics discarded on roadsides and in creeks.
- Respondents are looking to the CIWMB to provide grants similar to the Used Oil Block Grants, both to local government and nonprofit agencies that refurbish computers.
- Local government needs money for public education, as well as assistance with literature development and distribution. Several respondents would like to see the CIWMB take the lead and develop a statewide e-waste education campaign.
- Local governments want CIWMB to advocate on their behalf for extended producer responsibility (EPR) to:
  - Reduce toxicity of products.
  - Reduce resources consumed in the manufacturing process.
  - Design products for durability, repair, and recycling.
  - Develop take-back programs that shift end-of-life management from local government to manufacturers and retailers.
- CRT recycling/disposal should be paid at the point of purchase, not at the point of disposal. The final users of CRTs often have few financial resources and limited ability to pay for disposal or other processing.
- End markets are a high priority. Agencies operating e-waste collection programs are concerned about their waste generator liability, and they request mechanisms to ensure that e-waste recyclers are handling materials in an environmentally responsible manner.
- Program operators are concerned with liability associated with both smelters and overseas shipment, and they would like to see development of a strong glass-to-glass recycling capacity.
- Stakeholders agree on the need for more markets, especially local (West Coast) markets. E-waste collection facilities want to be notified of new end-possessing facilities as they open.

- Local agencies would have preferred a phased approach to regulation that would have allowed time for development of guidance and implementation strategies, as well as education and outreach.
- Some respondents question if disposal of CRTs in landfills is a threat to the environment and would like to see additional studies on lead leaching in lined landfills.

## Survey Description

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The primary objective of the survey was to determine the various target audience needs for proper management of e-waste. Respondents were also given an opportunity to make specific assistance requests from the CIWMB.

The open-ended survey asked respondents to prioritize their level of concern for issues involved in CRT recycling by assigning a rating of 1 to 4, with 1 representing no current concern and 4 as a high priority of concern.

The total number of respondents was 139. Participants were asked to indicate all of their jurisdiction's CRT management roles, which included local enforcement agency (LEA), certified unified program agency (CUPA), permitting and inspection (INSPECTOR), recycling coordinator (RECYCLE), solid waste facility (SWF), and household hazardous Waste (HHW).

Some participants indicated that they were involved in more than one CRT management activity, which increased the number of survey responses to 187. Because the survey did not ask participants to specify a primary function category, each reply is considered equally.

The survey asked respondents to indicate their level of concern about issues, including regulations, illegal dumping, collection points, storage, transportation, education, procurement, end markets, environmental safeguards, and finance. This report summarizes major concerns. Survey results are provided in graphs showing the percentage of respondents from each target audience that indicated a medium or high priority issue. Specific requests for assistance are discussed in the appropriate issue narrative.

## Issues Regarding CRTs

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### **Finance**

Each target audience rated finance as the highest priority. Local governments want financial assistance to address the costs of CRT management, and governing boards are reluctant to increase fees to residents. E-waste recycling costs cannot be absorbed in current refuse and recycling budgets and are competing for dollars with under-funded HHW programs. Rural counties have an added disadvantage due to lack of economies of scale, long transportation distances, and vulnerability to illegal dumping.

Many respondents believe that if consumers are required to pay for CRT recycling, illegal dumping will increase. Most programs that charge residents are subsidizing the costs. Many worry that costs will skyrocket as stockpiled CRTs enter the waste stream. As the volume continues to rise, staffing, storage, shipping, and recycling costs will increase proportionally.

Residents look to local government to help them get rid of their e-waste and have voiced their objection to charges for recycling and/or properly disposing of CRTs. Local government cannot afford to continue to subsidize diversion costs.

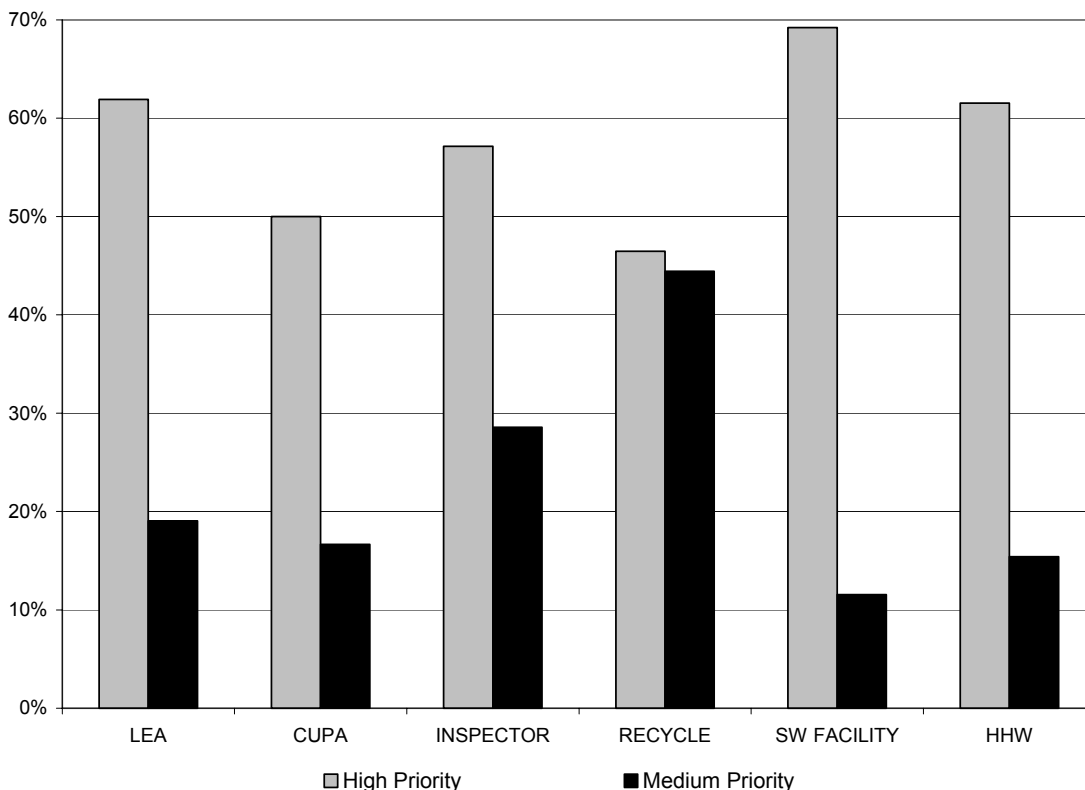
“Who will pay?” remains the big question. Legislative solutions for producer responsibility and/or advanced recycling fees are widely supported.

Many suggest that manufacturers, distributors, and retailers should take these materials back. Responsibility for disposal should remain with the manufacturer and those who profit from the product sales. Governments are also exploring opportunities to partner with manufacturers and retailers to provide recycling services.

CRT recycling/disposal should be paid at the point of purchase, not at the point of disposal. The final users of CRTs often have few financial resources and limited ability to pay for disposal or other processing. If the cost were built into the purchase of new CRTs, it would further encourage proper recycling. Funds from the fee could help finance new programs; build recycling infrastructure; offset collection, reuse, and recycling costs; and foster market development.

Respondents are looking to the CIWMB to provide grants similar to the Used Oil Grants, both to local government and nonprofit agencies that refurbish computers. A streamlined grant process, such as the establishment of block grants, is preferred over competitive grants. Block grants could provide the needed funding to initiate or expand emerging e-waste collection programs. The block grant structure would facilitate reimbursement for CRT recycling activities. An alternative suggestion to grant funding was straight reimbursement based on the weight of CRTs handled.

**Figure 1. Issue: E-Waste Financing**



## **End Markets**

Survey respondents ranked end markets as a high priority more often than any category except finance. Stakeholders agree on the need for more markets, especially local (West Coast) markets.

Collection facilities want to be notified of new end-possessing facilities as they open. These notifications would be of more help than listing entities that want to disassemble CRTs and act as middlemen.

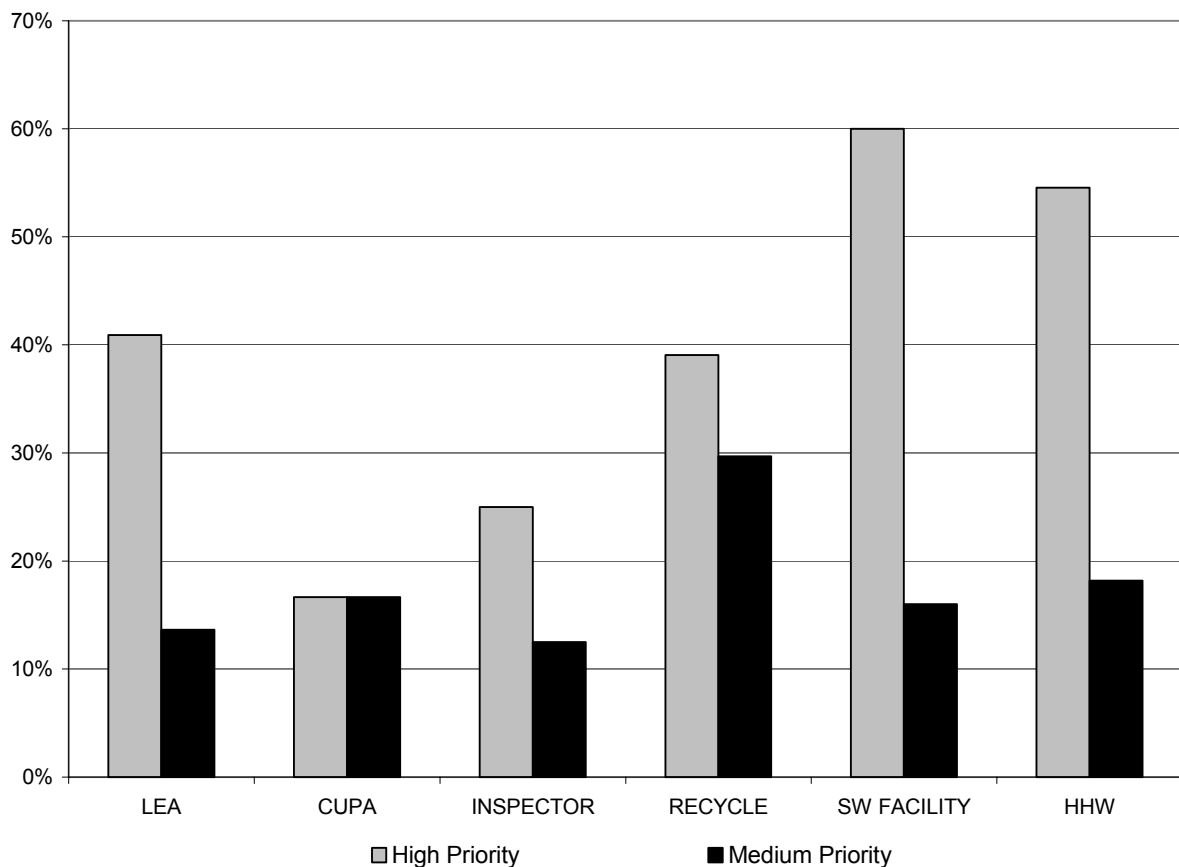
Agencies operating e-waste collection programs are concerned about their waste generator liability, and they request mechanisms to ensure that e-waste recyclers are handling materials in an environmentally responsible manner. Several respondents requested a certification process for universal waste recyclers. Local governments would like to have access to reports of recyclers' environmental compliance to assist in selection of vendors.

Of great concern was overseas shipment to countries without adequate environmental controls. Program operators realize the lack of adequate markets for domestic recycling and would like to see inspection and regulation of overseas recycling.

Respondents also expressed concern for the long-term liability associated with smelters and the desire to see development of a strong glass-to-glass recycling capacity. The CIWMB needs to continue working with industry to develop end markets for CRTs and other e-waste components. End markets should be aggressively promoted for end products like glass, plastic, and metals.

Organizations that accept, repair, and send materials to other markets for reuse could reduce the amount of e-waste. Although some schools still need computers, the local demand for older electronic equipment is generally low. Even giving away products can be difficult. Getting this equipment to those that could use it has substantial costs. Legal questions remain about software licensing and cradle-to-grave responsibility for donated equipment.

**Figure 2. CRT Issue: End Markets**



The electronics industry does not have a use for old components, which are not compatible with the new computers. Many believe that original equipment manufacturers (OEM) should be forced to take back their used products. If the manufacturers were responsible for the end markets, they would design the CRTs to be more readily recycled.

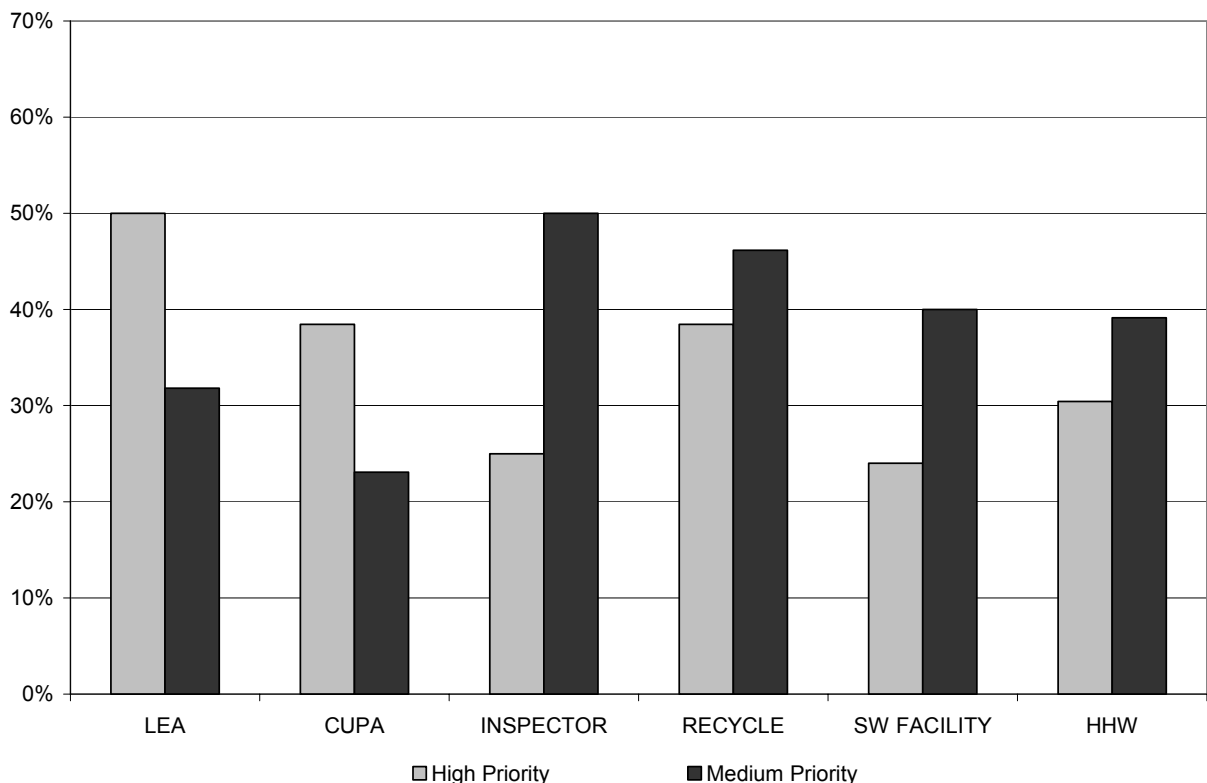
## Education

Although the media has covered e-waste recycling in great volume, many feel that the public is only gradually becoming aware of the requirements of recycling CRTs. Currently, e-waste recycling programs are promoted by local governments through a variety of methods, such as newsletters, brochures, and websites.

Education of the public was identified as a major need. Other targets for an educational message included regulators, local businesses, schools, and waste haulers. Additionally, elected and appointed decision-makers must understand the issues and costs of CRT management. (One agency is including postcards for participants to send to elected officials and companies as part of their e-waste collection event.)

Guidance and public education did not occur prior to the landfill ban. As a result, residents did not find out about the landfill ban until CRTs were rejected at disposal sites. Public education will help customers understand the need for special handling of CRTs. As stated by one respondent, “Going from included with municipal solid waste to banned from landfill and costing up to \$45 per CRT is a harsh transition for our poor community.”

**Figure 3. Issue: E-Waste Education**





Timing of the educational message by local jurisdictions is a dilemma. Many respondents report insufficient capacity for CRT recycling. They believe that an established infrastructure and adequate service options are needed prior to public education.

Since participation in collection programs increase with each educational promotion activity, funding to meet the demand for collection and recycling service is essential.

Local governments need money for public education as well as assistance with literature development and distribution. Several respondents would like to see the CIWMB take the lead and develop a statewide education campaign. Others would like assistance in the form of block grants to assist with local educational efforts.

Responsibility of manufacturers and retailers was emphasized. CRT buyers should be informed of disposal requirements at both retail point-of-sale and in CRT setup instructions. Also, computers and TVs should come with warning labels so the consumer will know they are purchasing something that will become hazardous waste.

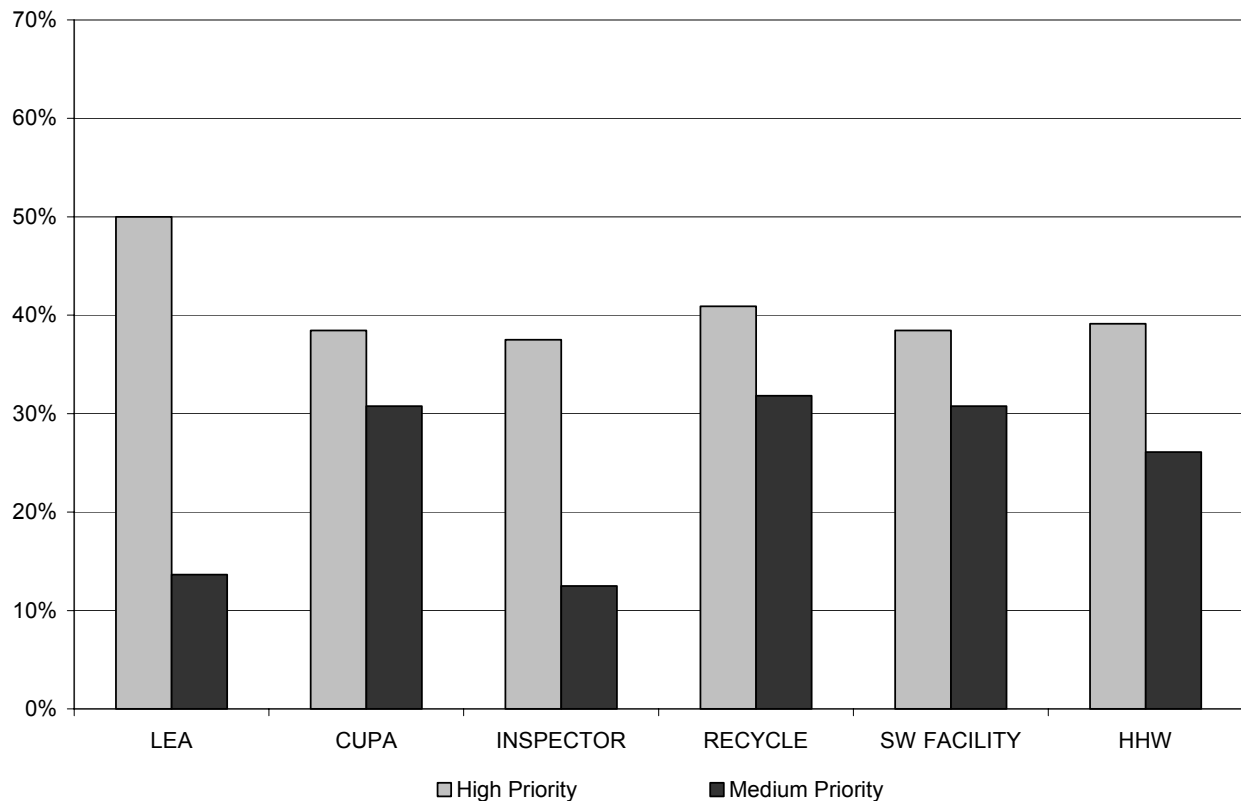
## ***Illegal Dumping***

Illegal dumping of e-waste is on the rise. Local government reports a correlation between CRT disposal charges to residents and the incidence of illegal dumping. CRTs are being hidden in loads of trash and dumped along county roadways, creek beds, and open fields; in alleys; and at thrift stores. One respondent reported finding pickup-size loads left in front of the landfill gate. Agencies that do not currently have illegal dumping problems have already established convenient collection programs and/or are heavily subsidizing or offering free CRT recycling services.

Local government, by default, is becoming responsible for electronics discarded on roadsides and in creeks. Illegal dumping greatly affects the workload of the emergency response teams or other responsible agencies. When CRTs are dumped, the glass can be broken and is difficult to clean up. Some respondents believe that dumping and CRT breakage is a source of greater environmental hazard than disposal in lined landfills.

One respondent asked for stronger regulations to improve chances of successful conviction of the dumpers, a fully funded cleanup fund that locals can tap into quickly, and monies for the investigation of these types of crimes.

**Figure 4. Issue: Illegal Dumping**



## **Regulations**

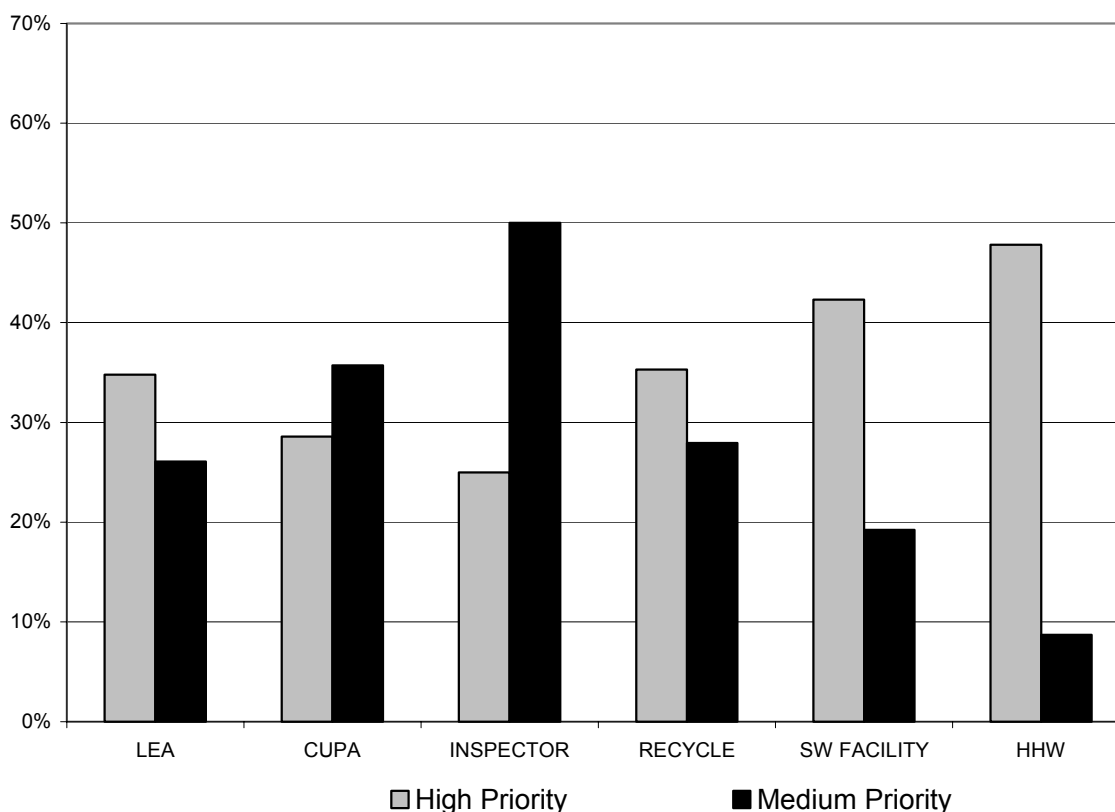
Local agencies would have preferred a phased approach to regulation that would have allowed time for development of guidance and implementation strategies as well as education and outreach to the numerous parties involved in the management of CRTs.

Implementation costs for the regulations are a major concern. The regulations are viewed by some as an unfunded mandate that places the burden, cost, and liability on local jurisdictions.

The following specific guidance needs are noted below:

- Further discussion and concise regulations as to how to register the haulers and storage sites and what minimum standards should apply to these sites.
- Clear and practical direction for management of CRTs that end up in the mixed waste at landfills and transfer stations.
- Regulations for the operation of one-day e-waste collection events and county auctions.
- Clarification on whether cradle-to-grave responsibility for proper disposal is still an issue for units donated or redistributed to needy groups, institutions, or individuals.
- Clarification of program licensing issues relating to giving or selling older units (for example, a computer with no operating programs is useless).
- Concern over financial assurance to clean up storage and hauler yard sites if the operators bail.
- Mandatory allowance for the crushing and separation at the earliest point to reduce shipping cost.
- Acknowledgement of necessary enforcement of regulations.

**Figure 5. Issue: CRT Regulations**



## Requested Assistance by Local Government

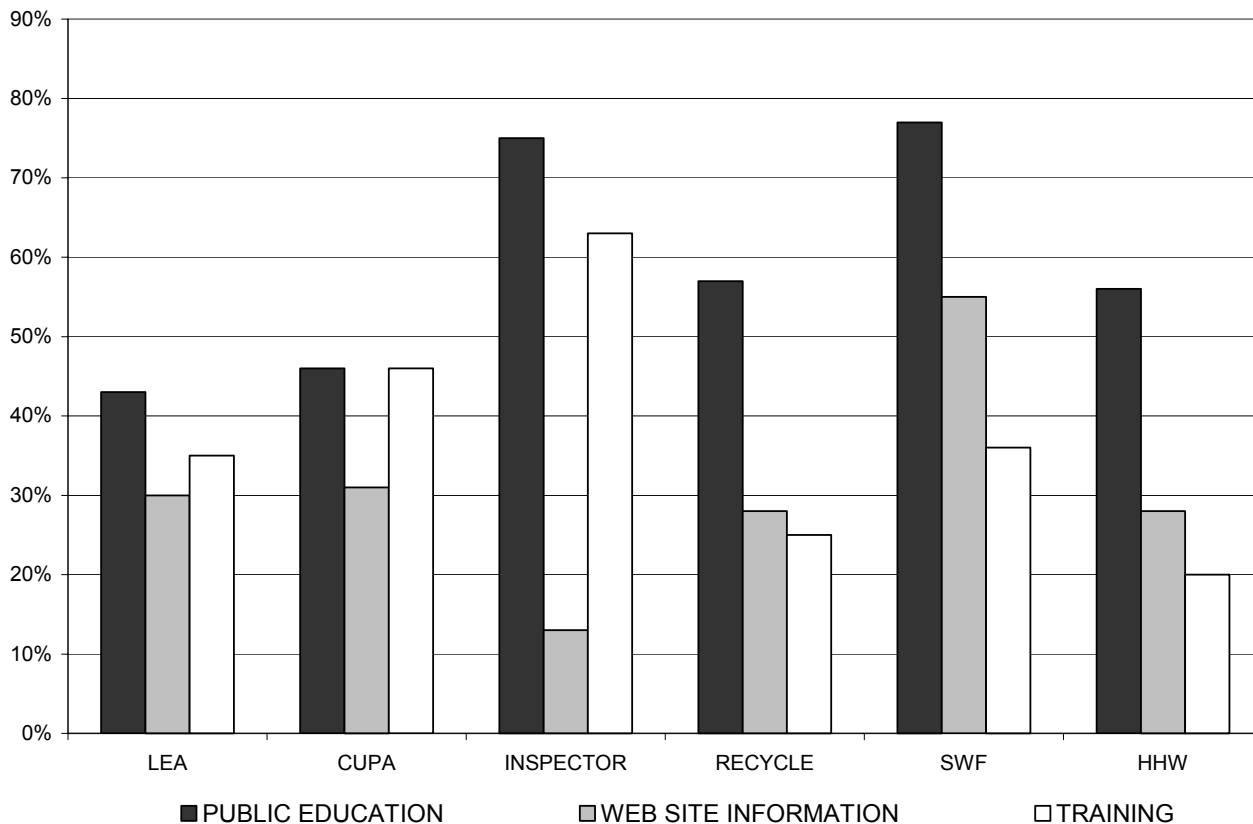
The survey offered an opportunity to indicate areas where respondents would like to see assistance from the CIWMB, and it allowed them to comment on the assistance needed. The target audiences have been grouped according to primary function into environmental compliance agencies and CRT collection agencies. These audiences could request educational assistance (public education, website information, training), guidance material (technical assistance, fact sheets, advisories, best management practices), regulatory, and funding assistance. Results are graphed to show the percentage of each group by assistance request.

- All local government groups placed priority on CIWMB assistance with public education.
- Although respondents indicated that producers and retailers should share in this responsibility, many felt that a statewide education program would be advantageous. Suggestions about the educational message included:
  - ▣ Explain exactly why CRTs are hazardous and why they need to be recycled.
  - ▣ Encourage thoughtful purchases to minimize the need for recycling/disposal.
  - ▣ Use simple straightforward public service announcements, similar to the Department of Conservation's "Good for the bottle/can" campaign.
  - ▣ Keep the message "recycle, reduce, reuse" alive.
- Best management practices were the most frequently requested guidance materials by all agencies.
- More than 50 percent of the responding collection agencies requested technical assistance, while compliance agencies were more likely to ask for training.

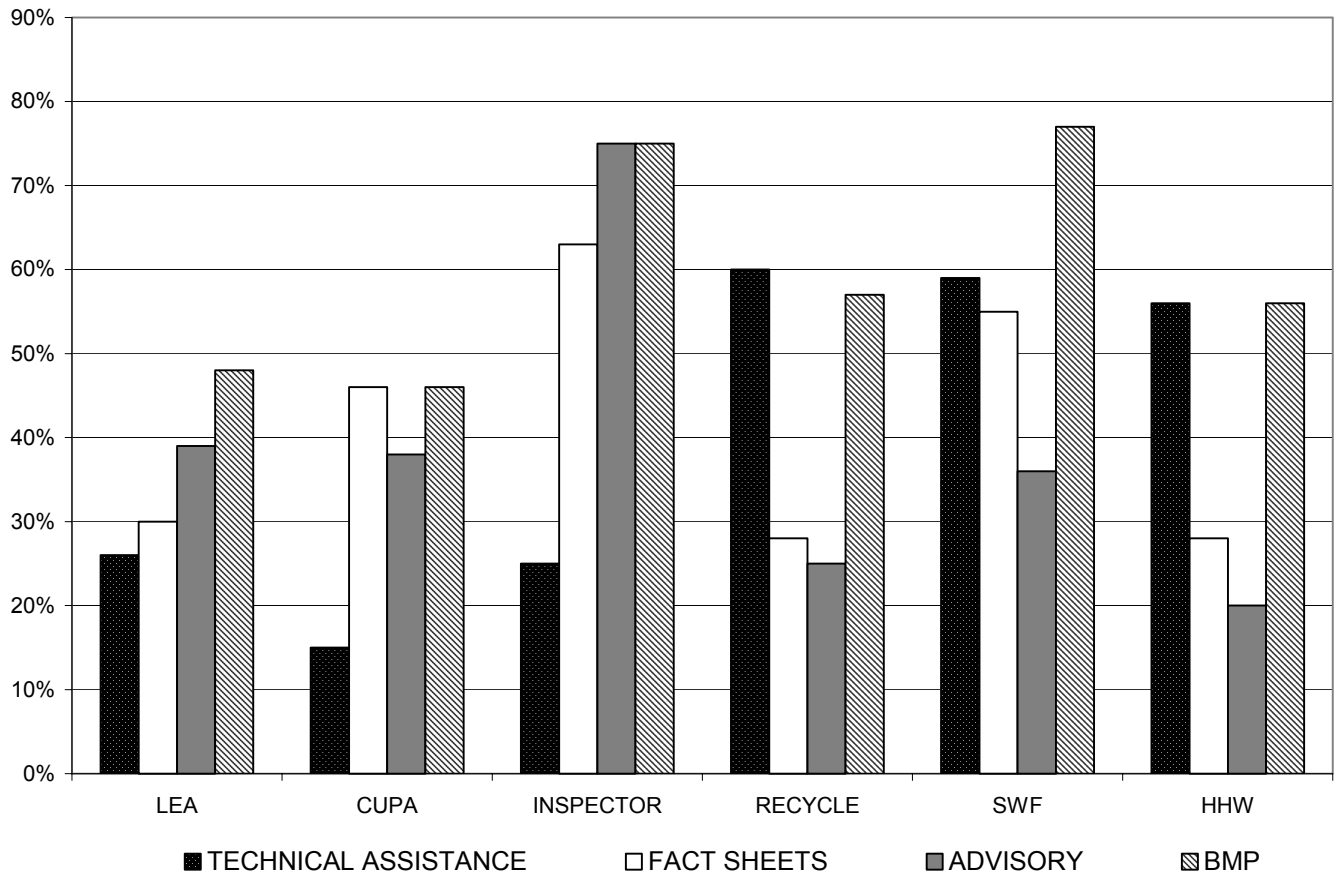
- Regulatory updates were requested from nearly 60 percent of respondents from every group. Compliance agencies were also more likely to request advisories, as well as statutory updates.
- Website information was requested less often than other types of educational assistance; however, the majority of respondents from solid waste facilities (55 percent) asked to receive information on the CIWMB website.

Results of assistance requests are presented as the percentage of respondents by audience category.

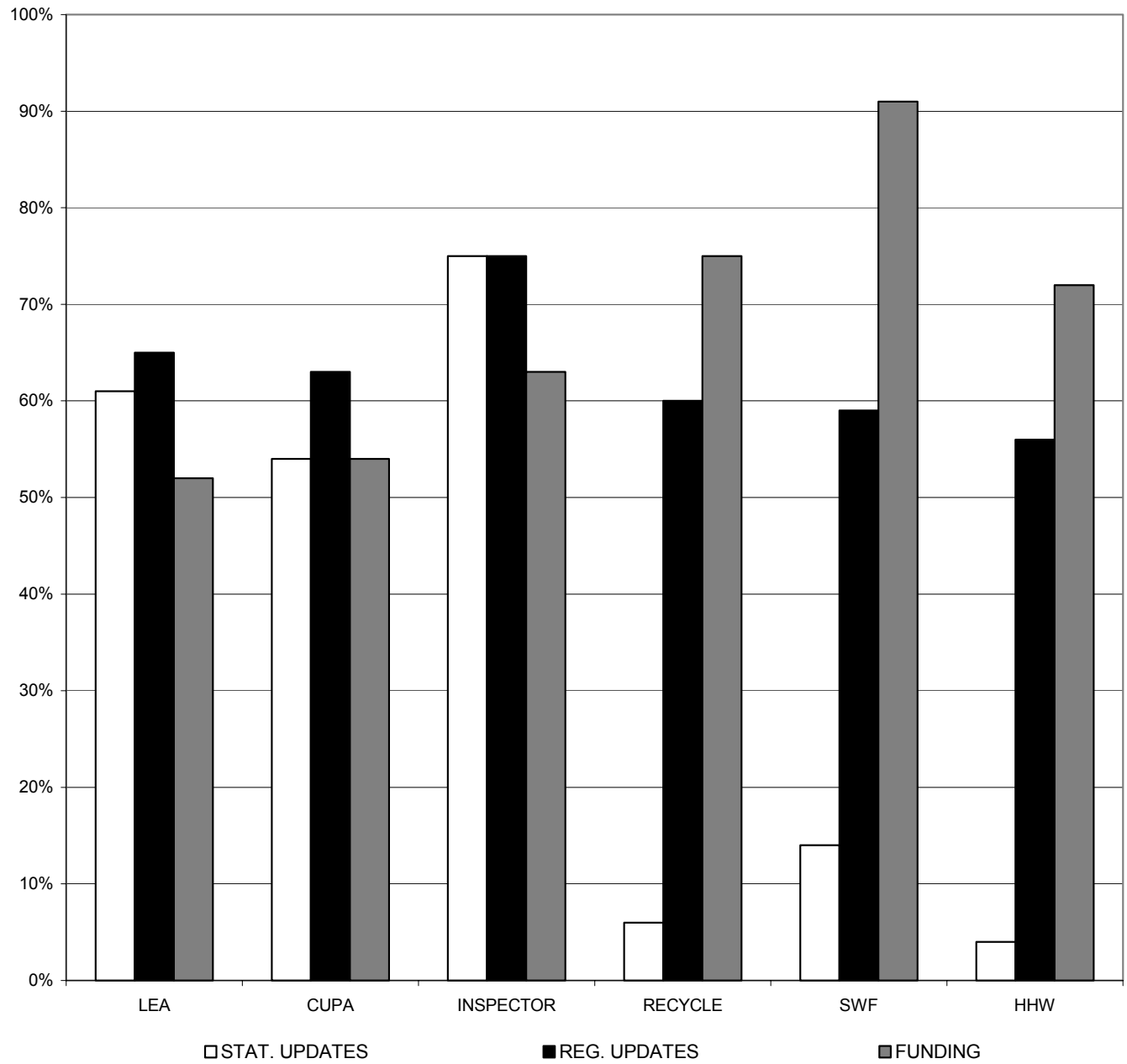
**Figure 6. Education Assistance Requests**



**Figure 7. Guidance Material Requests**



**Figure 8. Regulatory Assistance and Funding**



# **Appendix C**

## **Best Management Practices For Electronic Waste**

# Introduction

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This guide is written for public agency employees who may be tasked with finding a solution to a community's electronic waste problem. Many program options are available to effectively handle the ever-growing problem of electronic waste (e-waste). This guide is intended to walk you through the decision-making and implementation tasks in a simple step-by-step format.

This guide will briefly touch on the reasons that electronic waste has grown to such a problem and why it is important to handle these materials appropriately. However, this is not the primary intent of this guide. The California Integrated Waste Management Board Web (CIWMB) site has an extensive amount of information regarding the toxicity of electronic waste and the important reasons for handling this waste appropriately.

E-waste is the fastest growing segment of California's solid waste stream. The volume, weight, storage needs, and costs of e-waste management present special challenges as compared to managing solid waste or household hazardous waste. The guide discusses considerations for program design and contractor selection.

E-waste is hazardous waste if it is not properly managed, and cost cannot be the only consideration in managing hazardous waste. As with any hazardous waste, a local jurisdiction has CERCLA (superfund) liability for e-waste, which recommends due diligence in the final disposition of the material. Follow the materials to their end destination and ensure that all materials and components are recycled and do not end up disposed illegally or shipped overseas to eventually become someone else's waste nightmare. This is crucial to a successful program. As the collector of the waste, your jurisdiction holds liability for these materials through their final proper management.

The best management practices for e-waste are changing on a continual basis and will evolve over time. This guide will assist local government with implementing new programs and will probably be updated based on lessons learned to improve environmentally sound management.

Presently, metals are the only materials used in electronics for which cost effective, high-volume recycle streams already exist. The infrastructure for recycling other materials contained in electronics is still emerging. Research and technology development will likely result in more cost-effective and efficient collection and recycling programs.

## What to Know Before You Begin

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Before you start planning an e-waste program, you need to learn about the problem created by electronic waste and determine the reasons your jurisdiction is pursuing a solution to the problem. This section will cover the following subjects:

- Why e-waste is a problem.
- The hierarchy for handling e-waste.
- What to consider in designing an e-waste program.

### ***Why E-Waste Is a Problem***

Though the problem of e-waste seems to have emerged only recently, it has been building since the first computer or electronic product was manufactured. This makes the issue of current wastes, as well as long-term wastes, a more complex problem.



The following are just a few facts about the severity and extent of this problem. More complete information can be found on the California Integrated Waste Management Board (CIWMB) website at [www.ciwmb.ca.gov/Electronics/](http://www.ciwmb.ca.gov/Electronics/). Following are the facts:

- Consumer electronics comprises 2 to 5 percent of the total municipal solid waste stream.
- The consumer electronics waste stream is growing three times faster than the solid waste stream.
- An estimated 500 million computers will become obsolete in the U.S. by 2007 (according to the National Recycling Coalition predictions).
- More than 10,000 computers and televisions A DAY become obsolete and are put aside in California (according to the Silicon Valley Toxics Coalition).
- Three-quarters of all of the computers sold in the U.S. remain stockpiled in a garage, closet or storage space (according to a 1999 study by the National Safety Council's Environmental Health Center).
- Computers that will become obsolete by 2004 contain an estimated 1.2 billion pounds of lead (according to a study done by Californians Against Waste, ecoVenture, and the Silicon Valley Toxics Coalition).
- \$75–\$150 million annually could be spent on managing California's current output of obsolete computers and televisions.
- \$1 billion could easily be spent in the next five years to clean up the last 20 years of stockpiled obsolete computers.
- E-waste presents different challenges than household hazardous waste or solid waste recycling because of its weight, volume, storage needs, and costs.
- E-waste poses a long-term threat to public health and the environment because it is the largest source of heavy metals and organic pollutants in the solid waste stream.

### ***The Hierarchy for Handling E-Waste***

E-waste best management practices dictate that the waste is processed in the most environmentally desirable method. Environmentally desirable means that none of the waste will be handled in such a way as to contaminate the environment. If handled improperly, toxic components found in e-waste can find their way into the water or air and potentially cause serious illness or disease in animals and humans. A waste management hierarchy for electronics and processing residuals, in order of preference, is listed below:

1. Reuse of electronics equipment, components, or demanufactured items.
2. Recycling equipment or components for material recovery.
3. Management of components for energy recovery.
4. Disposal of components via incineration or landfill (least preferable).

### ***What to Consider in Designing an E-Waste Program***

The preliminary decision-making is a critical step in program design and one that should involve the high-level decision-makers in your jurisdiction. Questions to be answered include:

- What are the reasons for conducting a program?
- What types of waste do you want to collect?
- Will there be limits on the quantities of waste to collect?
- Who will be eligible to participate?
- Will there be a fee for participation?
- What agency should take the lead?
- Are there others that can be encouraged to take the lead?

- Are there beneficial partnership opportunities?
- Is there a model your community is already familiar with?
- Does this model offer a convenient program or should other types of programs be considered?

The following considerations should be examined in detail:

### **What Are the Reasons for Conducting the Program?**

- Regulatory requirements.

Jurisdictions may decide to conduct an e-waste recycling program only when regulations require them to do so. There are multiple regulatory requirements that jurisdictions are already responsible for meeting, and it is daunting to think that there may be a need to find resources for yet one more.

- Reducing quantity of waste going to landfill.

All jurisdictions are familiar with the state recycling goals established by the Integrated Waste Management Act. Recycling of e-waste may be a program that will further decrease non-hazardous waste disposal and contribute to your jurisdiction's ability to meet these recycling goals.

- Keeping heavy metals out of the waste stream.

The most environmentally conscious reason to implement an e-waste management program is the potentially dangerous impact to the environment if these materials are sent to a landfill. According to an U.S. EPA study, 40 percent of the lead in U.S. landfills is from discarded electrical and electronic products. The majority of this waste consisted of cathode ray tubes (CRT) in televisions and monitors. The lead in CRTs and the lead solder in printed circuit boards can migrate to groundwater and accumulates in the environment.

- Conservation of resources.

Electronic products contain valuable recyclable materials. As in any other recycling program, recovering these materials and using them for the manufacturing of other goods is an excellent way to conserve natural resources.

- Supporting reuse of computers with repair and training programs.

Some established programs utilize e-waste in training otherwise unemployed people. While some discarded electronic products are reusable with very little repair, the dismantling of electronic products to get to marketable components is a highly labor-intensive process.

- To generate revenue.

Though electronic products contain valuable materials, the sale of the materials alone will not support an e-waste collection program. Therefore, if your goal is to generate revenue, you will need to be more selective about the types of electronic equipment you accept in the program and charge a fee for service.

### **What Types of Waste Do You Want to Collect?**

E-waste is a general category for electronic products that are hazardous due to the toxic metals present in the solders, coatings, and glass. Generally, any electronic product with a circuit board or a battery will have hazardous characteristics. E-waste includes personal computers, monitors, televisions, keyboards, printers, telephones (including cell phones), typewriters, calculators, laboratory equipment, copiers, fax machines, and audio equipment.

Until February 8, 2006, residents are exempt from a landfill ban on hazardous consumer electronic devices. These items can go in the trash unless prohibited by local solid waste authorities. CRTs are not included in this exemption and must be managed as universal waste now.

Due to the CRT regulatory requirements, many municipal programs decide to collect only CRTs. However, residents will usually want to bring in a whole computer system rather than just a computer monitor, regardless of the program publicity.

Computer central processing unit (CPU) components have net recycling value when sent for metals recovery or are de-manufactured into circuit boards, hard drives, memory chips, microprocessor chips, and video cards. The salvage value of electronic equipment may offset some of the collection and recycling costs, if specified in the recycling contract.

### **Will E-Waste Recycling Programs Place a Limit on Allowable Quantities of Waste to Be Collected?**

Limits on the number of units that can be brought into a program can serve two purposes:

- To limit program use to residential quantities (residents are unlikely to have more than a couple of computers to dispose).
- To increase the number of residents that can be served within a given budget.

### **Who Will Be Eligible to Participate?**

Most collections are limited to electronic wastes generated by individuals at home and exclude hazardous waste from commercial and institutional generators. Some programs open collections to small businesses and schools on a cost recovery basis.

### **Will the Programs Charge a Fee for Participation?**

Nationally, about half of the e-waste programs charge a fee for recycling CRTs. Some programs offer free recycling for the first several items, and then apply a charge on additional equipment. Considerations in charging a fee include the following:

- Residents need to understand the cost associated with electronics recycling.
- In jurisdictions in isolated areas, some agencies feel illegal dumping will increase if fees are charged and prefer to offer free e-waste recycling.

### **What Agency Will Take the Lead In Sponsoring the Program?**

In determining who the lead agency will be, the following points should be considered:

- Does the agency currently have responsibility for waste management/recycling?  
Managing the flow of waste, whether it is solid waste, household hazardous waste, or recyclables, has parallels to e-waste management. A waste management agency will have experience in implementing the elements of an e-waste program such as contract management, scheduling, and transportation. Considerations include assessing the agency's ability to take on additional responsibility and how well the e-waste program complements current programs.
- Does the agency have knowledge of regulatory compliance requirements?  
Management of waste containing hazardous materials presents distinct challenges. An agency with knowledge of current regulatory requirements and experience dealing with regulated waste can provide valuable expertise when navigating the regulatory landscape. Under the universal waste regulations, the standards for collection and transportation are less strict than the usual

regulatory requirements. These products are still hazardous, and if not properly managed, they carry all of the liability of fully regulated hazardous waste.

- Does the agency currently manage an existing facility and/or collection infrastructure? Knowledge of the infrastructure necessary to conduct waste collection programs is critical. The experience gained in handling similar items (such as bulky goods, household hazardous waste, etc.) will eliminate the need to “re-invent the wheel” when implementing e-waste collection programs. Many jurisdictions decide to add e-waste programs to an existing collection program.
- Does the agency staff have expertise in program development/implementation? As in the development of an infrastructure, experience in developing and implementing collection programs will prove to be invaluable when developing an e-waste collection program. The steps are similar (planning, developing the infrastructure, promoting, etc.) and an agency that has gone through the steps before will most easily implement this program.
- Does the agency have experience in providing direct services to residents? An agency that is already providing direct services to residents will have customer service experience including resolving complaints, providing information, and answering questions. Another advantage would be familiarity with the demographics of the community and possible experience with program outreach and implementation.

### **Can Others Be Encouraged to Take the Lead?**

Your jurisdiction may not have to take the lead in managing the e-waste stream in your community. The best path for your community may be to educate others about the problem and convince them to offer an e-waste recycling program. Opportunities to explore could include the following:

- Nonprofit thrift stores.  
These charitable retail centers already have an infrastructure in place to accept donated used items. This could be a natural place for an e-waste drop-off center, either as a donation or with a fee. The thrift store would have the option to repair and resell usable items, which may provide job training or employment opportunities. Since a large percentage of products are not salable, your jurisdiction could arrange for transportation and recycling of products unusable to the thrift center.
- Retail businesses.  
Snohomish County, Washington, has developed a network of retail businesses that provide recycling services for computers, computer monitors, peripherals, and televisions. Participating businesses sign an agreement with the county and charge fees to residents if they choose. In return the county promotes these businesses. For information on the “Take It Back Network,” visit their website at [www.co.snohomish.wa.us/publicedu/solidwaste/programs/takeitback/network.htm](http://www.co.snohomish.wa.us/publicedu/solidwaste/programs/takeitback/network.htm).
- Contractor who will provide “turnkey” e-waste recycling.  
A “turnkey” e-waste recycling operation is one in which the contractor arranges all services from the parking lot to end markets. Your jurisdiction may decide hiring a contractor providing “turn-key” services is more cost-effective than directly implementing a program with jurisdictional staff.

Even if all services are contracted out, the public agency has hazardous waste liability if the electronic waste is improperly managed. Agency oversight and due diligence is necessary to ensure that the recycler and the end markets are managing your wastes in an environmentally sound manner.

If hazardous waste is not properly recycled, the generator or e-waste collection program can become financially responsible for Superfund cleanup under provisions of the Comprehensive Emergency Response, Liability and Compensation Act (CERCLA). Even though you are managing a contractor providing a turnkey program, the jurisdiction is still considered the generator.

Scrap metal dealers were given new liability exemptions in the 1999 Superfund Recycling Equity Act. If e-waste from your program is sold to a scrap metal dealer and somehow finds its way to a Superfund site, the liability burden can go back to your jurisdiction.

### **Are Beneficial Partnership Opportunities Available?**

Multiple opportunities for partnerships in implementation and management of an e-waste program in your community are probably available. Partnerships, especially regional partnerships, can aid in securing better services and getting better pricing. Possible partnerships include the following:

- **Regional (multi-jurisdictional) partnerships.**  
Creating a partnership (either formal or informal) with other jurisdictions in your region is an excellent way of maximizing the cost-effectiveness and efficiency of an e-waste collection program. Better prices and services may be secured through a regional contract as opposed to a contract between the recycling vendor and one jurisdiction because of higher volumes of e-waste collected for recycling.
- **State e-waste recycling programs.**  
Some states have established contracts with e-waste recyclers that can be used by local government collection programs. Statewide contracts eliminate the need for initiating bids and contracts for each jurisdiction, and offer a centralized compliance monitoring opportunity.
- **Other agencies within your jurisdiction.**  
All jurisdictions have asset management/property disposal responsibility for waste generated by their own operations. An e-waste recycler would benefit if your jurisdiction committed both municipal and residential equipment to the recycler. This is because the combined waste stream may include newer computers with resale value and may provide economies of scale for transportation and recycling. While government agencies and businesses have additional data security concerns, options for addressing these concerns could be addressed in the contract.

### **Does Your Community Have a Familiar Program Model?**

Selecting a program model that is consistent with existing special waste collection services makes sense, because residents have already been educated as to how to access the service. For example, curbside bulky item pickup programs could easily add electronic waste, and residents would know how to use the program. If residents were familiar with attending one-day HHW collection events, a one-day e-waste event would offer easy access. A Northeast Recycling Council (NERC) study of e-waste programs found better participation in e-waste collection programs when collection is held at the site where HHW collections usually occur.

### **Does This Model Offer a Convenient Program or Should Other Types of Programs Be Considered?**

Convenience can be measured by frequency of service, distance to collection points, and service ease. Residents will expect a service level similar to that for other special wastes and want it to be offered free or at a reasonable price. If the program location and/or service hours are perceived to be inconvenient, additional outreach and publicity will be needed to encourage participation.

# Benefits and Barriers to Collection Models

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A number of program models for e-waste recycling are available. These models have been used for the collection of recyclables, bulky goods, and household hazardous waste. Your jurisdiction may have one or more of these models in place for the collection of other types of materials, and you may want to consider whether to “piggy-back” the collection of e-waste onto an existing program or hold a separate event. You might use more than one model; for example, a drop-off event for a specific day along with nonprofit retail collection of e-waste ongoing throughout the year.

This section will cover the following most common collection models currently in use:

- Drop-off event (one-day or multiple days).
- Permanent collection facility.
- Curbside collection.
- Retail collection.
- Nonprofit/thrift retail collection.

## ***Drop-Off Event (One-Day or Multiple Days)***

A drop-off event is a one-day or multi-day program that allows residents to bring their electronic waste to a central location for recycling or reuse. Typically, the sponsor chooses a well-known and centrally located site to conduct the program. On-site activities include unloading vehicles and sorting and packaging wastes, followed by transportation to a recycling facility. At the end of the event, the facility or parking lot returns to its original function.

Most special waste collection programs begin as one-day events. Some programs go on to provide services at permanent facilities, while others find that special events are a better solution. Special events are a good way to serve residents in geographically large and diverse regions, because services can be brought to residents.

**Table 1. Drop-off Events—Benefits and Barriers**

Collection Model	Benefits	Barriers
Drop-off event	<p>Low up-front (setup) costs.</p> <p>Possible sponsorship opportunities.</p> <p>May use volunteers to offset labor cost.</p> <p>Media attention to raise awareness.</p> <p>Collect large quantities in short time.</p> <p>Cost control by limiting hours and frequency of collection events.</p> <p>Turnkey contracts eliminate need to hire additional municipal staff.</p> <p>Could be adjunct to an existing program using special events for collection.</p> <p>Residents may be familiar with special collection model.</p> <p>Good model for rural communities and first-time collections.</p> <p>Short time to implement (no permitting/construction barriers).</p>	<p>Requires extensive staff planning time.</p> <p>Volunteers present liability concerns.</p> <p>Publicity is primary driver for participation and will increase demand for service.</p> <p>Limited time for diverting equipment for reuse.</p> <p>Large quantities of waste can “bust the budget.”</p> <p>Contract costs expensive.</p> <p>Long waiting lines to drop off e-waste.</p> <p>May conflict with other events.</p> <p>Setup and breakdown must be done for each event; time consuming; expensive.</p> <p>Hard to predict participation numbers without appointment system.</p> <p>Hard to plan proper staffing levels.</p> <p>Each site will have specific limitations that must be accommodated in operation plan.</p> <p>Finding a site may be difficult; getting buy-in of owner.</p>

## ***Permanent Collection Facilities***

Permanent collection facilities offer regular collection hours for residents to bring electronic waste for recycling. These facilities are often combined with other municipal services such as recycling centers, household hazardous waste facilities, or solid waste disposal facilities. If the facility already has a fee collection infrastructure and staffing, sharing those resources may be a possible cost savings solution. Permanent programs require a larger up-front investment than one-day collections, but they have the potential to reduce costs through use of municipal employees instead of contractors.

E-waste is a bulky, high-volume waste stream, requiring large amounts of space for unloading, sorting, and storing. An existing household hazardous waste or solid waste facility may not be a good choice for an e-waste program if adequate storage space is unavailable.

**Table 2. Permanent Collection Facility— Benefits and Barriers**

Collection Model	Benefits	Barriers
Permanent Collection Facility	<p>Increased access to collection by extending hours of operation.</p> <p>Economies of scale possible because equipment is stored on-site.</p> <p>Extended time for diverting material for reuse.</p> <p>Can be an adjunct to another program (solid waste recycling; household hazardous waste).</p> <p>Year-round collection—service available when needed.</p> <p>No setup/breakdown needed.</p> <p>Participants become familiar with site; know where to take materials.</p> <p>Permanent workers have no training curve with each event.</p>	<p>Need permanent staff.</p> <p>Increased operational hours can increase staffing needs.</p> <p>Existing sites may not have adequate storage.</p> <p>New construction is cost-prohibitive.</p> <p>Difficult to find location to permit facilities.</p> <p>Permitting and construction takes a long time.</p> <p>Solid waste facilities (a likely e-waste facility location choice) are often isolated and not convenient to participants.</p> <p>Not mobile; cannot move to accommodate different geographic areas.</p>

## ***Curbside Collection Programs***

Curbside collection programs often are available in urban areas to handle bulky waste. These programs may operate as special spring or fall cleanup events, on-call pickups, or regularly scheduled pick-up. E-waste can be added on to an existing curbside program. Waste haulers can deliver the electronic waste to a central consolidation point or directly to a recycling facility.

**Table 3. Curbside Collection—Benefits and Barriers**

Collection Model	Benefits	Barriers
Curbside Collection	<p>Convenient for residents.</p> <p>Could be adjunct to existing program (bulky waste).</p> <p>Can be operated as neighborhood cleanup or by resident appointment.</p> <p>Neighborhood-specific promotion possible.</p> <p>Promotion through solid waste or utility billing.</p> <p>Cost per pound may decrease with increased volume.</p>	<p>Program (not resident) becomes responsible for transportation costs.</p> <p>Scavenging—e-waste could end up dumped illegally.</p> <p>Reuse potential diminished due to weather damage, breakage, or vandalism.</p> <p>Broken glass can result in accidents or stormwater contamination.</p> <p>Cleanup events encourage illegal dumping from other jurisdictions that are not contributing financially to the program.</p> <p>Overall costs higher due to higher labor costs and increased quantity of waste.</p> <p>More difficult in rural areas.</p>



## ***Retail Collection***

A local store might be willing to allow residents and/or small businesses drop off specific types of e-waste at their retail location. This type of partnership is most often made with a business that sells electronic products. Sometimes the business is willing to give discounts on the purchase of new equipment if the resident brings in their obsolete equipment at the time of purchase.

**Table 4. Retail Collection Program—Benefits and Barriers**

<b>Collection Model</b>	<b>Benefits</b>	<b>Barriers</b>
Retail collection	<p>Program flexibility: ongoing program or one-day collection event.</p> <p>Advertising and collection service can increase foot traffic for retailer.</p> <p>Retailer can promote new equipment sales (take-back program in return for product discount).</p> <p>Retailer gets “green” reputation.</p> <p>Opportunity to pursue shared costs of transportation and recycling with retailer.</p>	<p>Retailer recycling contracts may not meet agency environmental requirements.</p> <p>Retailers may not have adequate storage space.</p> <p>Take-back is not a core retail business activity.</p> <p>Difficult to get corporate approval to participate.</p>

## ***Nonprofit/Thrift Retail Collection***

This collection model is similar to the retail collection model but is focused on nonprofit or thrift stores. These types of stores already accept donation of other used items (such as clothing, furniture, etc.) and have a complete infrastructure in place to do so.

**Table 5. Nonprofit/Thrift Retail Collection Program—Benefits and Barriers**

<b>Collection Model</b>	<b>Benefits</b>	<b>Barriers</b>
Nonprofit/thrift retail collection	<p>Already have drop-off infrastructure.</p> <p>May already have pickup infrastructure.</p> <p>Better potential for resale and re-use as compared to other models.</p> <p>Provides nonprofit with inventory source.</p> <p>Have 501(3)(c) status, offering tax advantages for donations.</p> <p>Possible job training opportunities.</p>	<p>May need agency assistance with recycling costs for unusable materials.</p> <p>Possible increase in illegal dumping at donation stations.</p> <p>No trained staff for refurbishing/repairing electronic equipment.</p> <p>May not have adequate storage.</p> <p>May not be able to resell due to technical obsolescence.</p> <p>Computer repair and recycling not core business activity.</p>

# Selecting an E-Waste Contractor

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Selection of a contractor to manage e-waste is perhaps the most critical step in ensuring successful program implementation.

## ***E-Waste Is Hazardous Waste***

When government agencies accept universal or hazardous waste from residents, they take on hazardous waste generator status for that waste. Under California regulation, electronic waste (e-waste) is classified as universal waste. The universal waste regulations are less restrictive than hazardous waste management standards, in order to encourage recycling of these hazardous wastes. However, if universal waste is not properly recycled and/or disposed, it is legally considered a hazardous waste and is subject to full regulatory requirements.

A bill of sale or transfer of title does NOT sever cradle-to-grave generator liability (CERCLA) for proper disposal of e-waste. Likewise, a certificate of recycling is only as good as the information it contains about how and when your waste was managed, **and it is not a regulated document**.

If a recycling vendor fails to properly manage the electronic scrap, your agency could be held responsible for environmental cleanup, years after the work is completed.

## ***Consider an RFP Rather Than a Bid***

Long-term liability for potentially hazardous waste needs to be a primary concern for public agencies. With hazardous waste management, cost is not the most important factor. Bids require acceptance of the **lowest cost proposal** from a responsible and responsive bidder. Use of the RFP process offers several advantages over the bid process:

- Price is only one consideration in vendor selection.
- Competing proposals can be evaluated according to their merits and an award made to the **most advantageous proposal** to the agency.
- The RFP can encourage respondents to propose their own innovative or cost-effective approaches to benefit the agency.
- The RFP method permits discussions after proposals have been opened to allow clarifications and changes in proposals.
- Evaluation criteria can reflect your agency's program goals and can include the disposal strategies, financial stability, personnel qualifications, references, recent audits, waste management plans, and documentation.

## ***Gather Input Outside Your Expertise***

Early in the planning process for the RFP, it is important to notify and request input from other departments and agencies whose advice will be critical to the success of the RFP and service contract. Most agencies have existing policies about how the proposal/bidding process operates.

- The **Procurement Agent** will help you understand the jurisdiction's guidelines and required language to include in the RFP, such as equal opportunity and non-discrimination clauses, preference for local firms, and other required notices. Agency contracting policies also will specify when governing board contract approval will be required.
- The **Risk Manager** needs to be involved in developing indemnification language, insurance (levels) requirements, bond requirements, and contract default or termination provisions.
- The **Fiscal Officer** should review financial audit data submitted by the prospective contractors to ensure that the selected firm is fiscally stable.

- The **Attorney** must review the document for legality and completeness and ensure that the key terms and conditions anticipated in the final contract are incorporated in the RFP.
- Ask **other agencies** with an e-waste program for a copy of their RFP and incorporate useful information into your document.

## ***Start With the End in Mind***

The purpose of the proposal process is to help you determine if the contractor has the background, expertise, price, and track record to meet the needs of your organization. You need to ask prospective contractors for information and documentation about their company, all subcontractors, and end markets, as well as to provide a proposal for service and pricing. The RFP should also require the proposal writer to demonstrate the capacity to accept all of the materials that you want to collect, the ability to implement the program within the anticipated schedule, and to provide the desired services.

An important outcome of the RFP process is to solicit competing proposals that can be compared and evaluated according to your selection criteria. Proposal writers need specific instruction as to:

- The scope of services and desired outcomes.
- The requirements for the format and order of proposal presentation
- The cost proposal and pricing units.
- All documentation required with the proposal.

The level of service you request may be based on existing resources such as trained labor and equipment. While some communities will want to utilize staff currently working in solid waste, recycling, or HHW programs, other communities may prefer a “turnkey” service where the vendor is responsible from parking lot to end market.

## ***Tell Proposal Writers About Your Project***

If you have an existing program, begin with a detailed description of services currently being provided. Proposal writers need an intent statement that summarizes primary goals and services desired. Be sure to include:

- The targeted waste categories.
- The population and demographics of the geographic service area.
- The types of collection participants (for example, households, businesses, schools).
- The collection model (drop-off, curbside, etc.)
- The proposed collection site(s) and date(s).
- Use of in-house staff and volunteers and the tasks they will perform.
- Plans for education and publicity (to help estimate participation rates).
- Equipment that will be supplied by the sponsor—forklifts, port-a-potties, etc.
- Waste handling requirements and waste management preferences.
- Performance standards: details on the expectations of jurisdiction.
- Requirements for verification of recycling or disposal.

## ***Ask for Contractor/Subcontractor Qualifications***

A qualifications statement for the contractor and subcontractors should:

- Identify the type of business (broker, refurbisher, demanufacturer, metal recovery) and the type of organizational entity (corporation, sole proprietorship, partnership, joint venture, etc.).
- Provide a statement of ownership and list the officers and principle stockholders.

- Detail the number of years in business and their experience with managing e-waste and residuals.
- Include vendor experience, including references from any previous e-waste collection programs.
- Provide an audited financial statement for a one-year period, prepared by an independent certified public accountant, no more than 12 months old.
- Ask for the Environmental Management Systems (EMS) certifications of the contractor and subcontractors. (See sidebar on page 40 for explanation of EMS).

Ask prospective contractors to **identify all of the subcontractors, marketers, facilities, and transporters** along with their role in the management of the waste electronics and processing residuals. For each entity, the business name, address, U.S. EPA ID number, DOT transporter number, contact person, and telephone number should be provided.

## ***Check Regulatory Compliance***

The contractor and all subcontractors must be in good standing with the regulatory community. The contractor and all proposed subcontractors, as well as companies responsible for dismantling, sale, reuse, and recycling of materials, should consider the following elements of regulatory compliance:

- Requesting copies of federal, State, and local licenses; relevant permits; and registrations.
- Asking for narrative of all notices of violations, administrative orders, or other enforcement actions taken by regulatory agencies during the past three years.
- Verifying that closure plan and financial assurance plan are in place.
- Ensuring that required environmental planning documents are available, including the hazardous materials management plan, hazard communications plan, right-to-know training program, and worker safety program.

The Electronics Waste Recycling Act will provide reimbursement for costs of covered electronic waste only if the processing facility is in compliance with all applicable laws and regulations and has been inspected by the Department of Toxics Substances Control (DTSC) within the past 12 months. Recycling or refurbishment facilities must certify inspections conducted of their facilities and follow their environmental compliance plans for health and safety and employee training. This compliance self-certification is not the same as environmental management certification that is discussed below.

## ***Request Environmental Management Certification***

Universal waste handlers are not subject to the same level of regulatory compliance inspections and permits as hazardous waste facilities. Still, e-waste is hazardous waste if it is not properly managed, and local government is legally responsible for waste it collects. In a CIWMB survey, local government requested e-waste recycler certification as an assurance that the companies are meeting standards. Governmental resources are currently not available to initiate a program to certify e-waste recyclers.

However, several voluntary environmental management systems (EMS) programs are available that certify a business is meeting established standards for business practices, regulatory compliance, and sound environmental performance. Third-party independent auditors certify compliance with program standards. Descriptions of existing EMS programs are included in the sidebar.

No single EMS standard is currently prevalent for e-waste recyclers in this country. However, EMS certification is a commonly required contractor qualification in Europe. Proposal writers

need to discuss their environmental management systems and their intentions towards meeting international environmental standards. Companies will become certified if preference is given to EMS certified companies.

## **ENVIRONMENTAL MANAGEMENT SYSTEMS**

Environmental Management Systems (EMS) set standards for business practices, regulatory compliance, and sound environmental performance. In addition to regulatory compliance inspections, “independent” third-party auditors inspect the business to certify compliance with environmental standards.

**ISO**—The International Organization for Standardization (ISO) mission is to develop standards that are accepted across international boundaries and create a level playing field for international trade. The ISO 9000 series addresses organization processes and quality. The ISO 14000 series addresses the impact of the organization's activities on the environment and requires continual improvement in the area of environmental impact.

**EMAS**—the Eco-Management and Audit Scheme (EMAS) is a European voluntary program that requires participating organizations to implement an environmental management system (EMS) that must meet the requirements of the ISO 14001. Many organizations progress from ISO 14001 to EMAS and maintain certification/registration to both. Participating organizations must regularly produce a public environmental performance statement, with accuracy and reliability independently checked by an environmental verifier.

**IAER**—the International Association of Electronics Recyclers is a trade association that has developed a certification process for electronics recyclers. Their certification standard addresses management systems for environmental quality and health and safety. To be certified, companies must successfully complete an IAER pre-screening process and may elect to use available IAER “audit preparation” consultation services. An independent registrar selected by IAER performs an on-site audit. The IAER issues a certification to the electronics recycler upon successful audit completion.

## ***Plan to Provide Services***

Services that may be required in a proposal include collection, segregating, packaging, loading, transportation, unloading, de-manufacturing, recycling, and audit trail documentation of the electronic equipment.

Generally, proposal writers are asked to provide a detailed narrative of operational services responding to services requested in the RFP. The contractor's narrative description of work should provide a full description of the services to be performed:

- A detailed resource logistics plan including needs for staff, equipment, material storage, and transportation vehicles, as well as the technical/professional experience of key personnel assigned to the project.
- The proposed methods for handling, on-site sorting, inventorying, packaging and labeling the waste at the collection site.
- The plan for managing used electronic equipment, including transportation, storage, processing, dismantling, salvage, sale, reuse, and/or recycling for each type of equipment and processing residuals. This section should also provide information on the proposed facilities and the specific activities that each will perform.
- Health and safety plans covering standard operating procedures, accident prevention, and a contingency plan that describes management and cleanup measures in the event of inclement weather, accidents, fires, explosions, and hazardous waste releases.
- The data and reports the contractor will provide to assist in evaluating the program.
- Samples and descriptions of the audit trail/certificates of recycling (See sidebar.)

### **Certificates of De-Manufacturing, Recycling, and Disposal**

These certificates are not regulated, and they are only as good as the information they contain. In the RFP, specify the information to be included on the certificate and request a sample certificate.

A certificate of recycling should provide certification and supporting documentation that all materials collected have been processed, recycled, and/or disposed. Although a certificate does not relieve you of cradle-to-grave liability, it can help protect your organization if it accomplishes the following:

- Provides an audit trail that traces e-waste from the collection site to the final processing or waste management facility.
- Contains the name and address of the processing facility, date of processing, identification of the waste material, and management/processing technique utilized.
- Assures the ultimate dismantling, salvage, sale, reuse, and/or recycling.
- Provides a unique identification number from bills of lading (shipping papers), and unique identification number from associated invoice.
- Details the percent of the materials recycled after donation, refurbishment, or deconstruction.
- States that the contractor assumes title and ownership for all electronic equipment collected.

**Consider withholding processing payment (or a significant portion of payment) until the recycling certificate is received.**

## ***Insurance and Indemnification***

Legal and risk management groups should be consulted to determine the types and levels of insurance and indemnification requirements for the contract. Government agencies will likely require that the contractor can indemnify, defend, and hold harmless the jurisdiction and its agents and employees. Certificates of insurance verify that the required coverage is in effect. The

risk manager may require that the insurer have an acceptable rating in the *Best's Key Rating Guide*.

### **Types of Liability Insurance?**

- Workers' compensation insurance (employees and subcontractors).
- Commercial general liability.
- Commercial automobile liability.
- Contractor's pollution liability or pollution errors and omissions liability insurance.
- Performance guarantees and/or bond provisions for the quality and completeness of the work to be performed.
- Supply chain subcontractor/vendor.

### **Cost Proposal**

A fair comparison of cost proposals will require that all proposal writers are using the same cost units. Some contractors charge by the unit, while others charge by the pound for electronic waste. The pricing unit structure for e-waste programs continues to evolve as e-waste programs gain experience, so it may be helpful to consult with other programs and potential proposal writers to determine the best pricing units for the RFP. For evaluation purposes, a pricing matrix will facilitate cost comparisons. Provide a hard copy and electronic version of the price matrix form for proposal writers to complete.

Be specific about what is included in a unit price. If the program specifies "turnkey" prices, be sure to list all items to be included in the cost. For instance, does the price for a CRT include collection, sorting, packaging, labeling, transportation, processing, and recycling certification? Does the price include costs for the on-site use of the contractor's equipment such as forklifts or pallet jacks? Will a separate charge be included for in-office support or event reports?

In the operations narrative the contractor specifies the plans for staff, equipment, material storage, and transportation vehicles. If items listed in the narrative are not included in the "turnkey" cost, the proposal writer should identify line item costs for those items. Alternatively, some contractors will provide a list of items to be included in a "fixed cost" for conducting the collection.

Typically, labor costs are itemized and invoiced separately. The RFP can specify that labor hours be paid for actual operating hours. Some contractors may charge mobilization costs per person, per day, that include travel time, personal mileage, and lunch for contractor staff or subcontract staff.

The contract should state that additional costs would not be incurred beyond the costs proposed throughout this agreement, without the consent of the sponsor. Costs for managing an unusual waste received at the collection would be discussed and negotiated on a case-by-case basis.

## **Planning an E-Waste Event**

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The steps needed to plan a one-day collection event can also be used for other program models. The steps for planning an e-waste collection event discussed in this section include the following:

- Identify and write clear goals for your program.
- Get buy-in from all stakeholders.
- Develop a request for proposals (RFP).
- Develop a program work plan.
- Select a site.

- Design the layout of the site.
- Determine staffing and training needs and develop training materials.
- Determine equipment needs.
- Estimate participation and costs.

## ***Identify and Write Clear Goals for Your Program***

The first step in designing an e-waste collection event is to determine what your jurisdiction wants to accomplish by having an e-waste collection program. Well-defined goals can direct you in all aspects of planning the event. The work plan goals serve as the focal point to which you will continually return to ensure that every planned activity supports your jurisdictions' primary goals.

Reasons for conducting an e-waste collection program may include the following:

- To meet regulatory requirements.
- To reduce the quantity of waste going to the landfill (or increase recycling rates).
- To keep heavy metals out of the waste stream.
- To conserve natural resources.
- To support reuse of computers with repair and training programs.
- To generate revenue.

Each of these reasons is described in detail in the section of this plan entitled "What You Should Know Before You Begin."

## ***Get Buy-In From All Stakeholders***

Implementation of an e-waste program in your jurisdiction will affect a number of agencies, groups, and individuals. These potential stakeholders should be involved early in the planning stages for an event. Though it may seem time-consuming and difficult to get stakeholder buy-in before implementing your program, it will actually save time in the long run. Your program is less likely to be derailed during implementation by a stakeholder whose agreement was not obtained.

The written program goals are the tool to inform stakeholders about the reasons and necessity of offering an e-waste collection program in your community. Stakeholders can offer valuable input that will be important in detailing your program.

Identifying stakeholders may be difficult. An important rule of thumb is to include everyone you believe may be remotely interested in what you are planning. Better to approach a potential stakeholder and be told they really have no interest than to have someone that you have forgotten come forward during implementation.

Some potential stakeholders in an e-waste collection program are:

- City manager or county executive.
- City attorney or county counsel.
- Finance department.
- Police.
- Fire department.
- Hazardous waste compliance program.
- Local enforcement agency (solid waste).
- Solid waste management staff.
- Public works staff.



- Household hazardous waste staff.
- Citizen committees.
- Local e-waste recyclers.

## ***Develop the Program Work Plan***

A program work plan will provide you with the framework for building your program and it will be useful to ensure you stay on-course throughout the planning, implementation, and evaluation of the event. This plan needs to detail the required actions, responsible staff, and timelines.

Considerations include:

- Selecting a collection site.
- Designing the collection site layout.
- Determining staffing and training needs.
- Determining equipment needs.
- Estimating costs and participation.
- Data collection and reporting.
- Program evaluation.

### **1. Selecting a Collection Site**

Proper site selection, design, and operation are crucial in promoting maximum participation in the event. An easily accessible, efficiently run site will help ensure positive experiences on collection day, which can result in favorable publicity for the next event.

First determine the criteria to be used in selecting a site. An ideal site would be one that:

- Is well known by people in the community.
- Is highly visible.
- Is centrally located and easily accessible.
- Is near major streets and has simple map instructions.
- Provides space to queue traffic without disrupting regular traffic.
- Has an impermeable surface (for example, pavement or concrete) to minimize environmental risks and facilitate the use of a pallet jack.
- Has on-site utilities (running water, fire hydrants, electric hookups, and telephones).

Collection programs are often held in public locations such as schools, public works yards, stadium parking lots, household hazardous waste facilities, solid waste landfills or transfer stations, fire stations, or buildings with large parking lots. Whether the collection will be held on private or publicly owned land, it will be necessary to get the written permission of the site owner. An agreement between the sponsor and site owner should describe collection activities and responsibility for liability incurred by use of the site.

Also, you want to be sensitive to neighboring businesses or residents. It is advisable to do “good neighbor visits,” informing the neighboring businesses or residents of the planned activity on the site and educating them as to the importance of e-waste collection events. Assure neighbors they are not incurring any risk from this type of collection event. E-waste collection events will certainly not result in the smells, toxic releases, or problems associated with other types of collection events.

### **2. Designing the Collection Site Layout**

The site layout should allow participants to move through the collection area quickly and efficiently. The site design will be detailed on a map showing all the pertinent information. This

map will be used for staff training, for setting up the site, and for post-event evaluation. Points to consider when designing the layout of your collection site include:

- Queuing of traffic.
- Sensible and well-marked traffic flow patterns.
- Multiple unloading areas.
- Unloading participants' vehicles.
- Minimal distance from vehicle unloading to sorting and packaging areas.
- Area for completing survey information and handing out informational brochures.

Details of these considerations:

### **QUEUING OF TRAFFIC**

The site plan must accommodate lines of traffic entering and leaving the site. These waiting lines should not interfere with the normal street traffic patterns around the site. In designing the site plan, anticipate the maximum number of participants and traffic overflow. This way your site is prepared to handle the worst possible scenario.

### **SENSIBLE AND WELL-MARKED TRAFFIC FLOW PATTERNS**

The flow of traffic should accommodate easy entrance and exit of the site. If possible, plan for one-way traffic flow through the site. Ample room should be available to accommodate the turning radius of large vehicles. The site must allow adequate area for contractor's trucks and the possibility of needing to bring in extra supplies or equipment.

Also, the site map should include specifications for how traffic flow will be marked and where the markers will be placed. Markers may be traffic cones, sawhorses with attached signage, people directing traffic, or any other method that is clear and leaves no possibility for misunderstanding by the public.

### **MULTIPLE UNLOADING AREAS**

The set-up of the unloading areas will be determined in part by the packaging requirements of the recycling contractor. Unloading areas can be set up for specific types of materials, such as separate stations for CRTs, computer towers, and small electronics. The site plan should identify the number and location of unloading areas. Several traffic lanes with separate unloading stations may be preferred for large events.

Plan on setting up a separate unloading area for participants with special needs, such as large loads of e-waste, that would delay traffic flow. Alternatively, items being isolated for repair or reuse may need to be directed to a special unloading area, allowing more time for handling and storage. In these situations, the flow should be designed so participants can enter and exit the special areas safely, within the flow of the overall event traffic.

### **UNLOADING PARTICIPANTS' VEHICLES**

For household hazardous waste (HHW) collection events, participants are required to stay in their vehicles while event workers unload the materials. E-waste products do not pose the same health exposure hazards as HHW, so there is no regulatory requirement that participants remain in their cars. Depending on the anticipated participation, residents could be asked to unload their own electronic waste. However, having event workers unload cars will facilitate traffic flow and limit possibilities of participants being injured or involved in an accident. This is an important consideration because of potential liability concerns for the jurisdiction and site owner.

## **MINIMAL DISTANCE FROM VEHICLE UNLOADING TO SORTING AND PACKAGING AREAS**

In planning the distance between unloading and sorting stations, you need to provide adequate space for staging the materials before they are packaged. Therefore, the optimum distance is dependent upon the anticipated volume of materials and the number of staff available to move materials through the collection site. Using carts to transport materials between the unloading and sorting areas can decrease the level of effort needed to move materials and the chance of worker injuries.

## **AREA FOR COMPLETING SURVEY INFORMATION AND HANDING OUT BROCHURES**

Surveys can be given to participants as they enter the event. Participant surveys will provide you with valuable information to evaluate the event outcome and provide input for improvements for your next event.

You should use the event as an opportunity to educate participants about the problems associated with e-waste. Although you can assume that event participants have some knowledge of the issues, the brochures will most likely still provide information useful to the residents as to the toxicity and the potential health risks, as well as listing other products that will become e-waste when discarded.

As residents pass through the site and see piles of obsolete electronic equipment, they may be particularly receptive to the message of avoiding waste generation by looking for upgradable products that will have a longer life span. This is also a good opportunity to provide residents with information on smarter purchasing choices to avoid creating e-waste in the future.

### **3. Determine Staffing and Training Needs**

Below are some ways to staff an e-waste collection event:

- City or county staff.
- Volunteers.
- Recycling contractor's staff.
- Nonprofit or reuse staff.

Most likely a combination of these types of staff will be used depending on the jobs or activities being performed. The first step is to determine the types of jobs that will need to be performed at the event. These will include the following:

- Project coordination.
- Setup and breakdown staging area.
- Screening incoming materials.
- Unloading cars (if planned and trained for).
- Quantifying material collected by type.
- Maintaining operating records.
- Segregating and storing appropriately.
- Training employees on health and safety policies and regulations.
- Directing traffic.
- Ordering supplies.
- Inspecting equipment for reuse potential.
- Weighing storage containers if charged by the pound (should be done as double check even if recycler is contractually providing this service).
- Palletizing and wrapping for transporting.

- Writing weight on pallet or container.
- Counting and keeping track of what goes into containers.

The type of staff used for each task will depend on the level of knowledge needed for that task. For instance, staff unloading materials need have little knowledge of the e-waste stream; they need to be physically fit and trained in proper lifting techniques. The staff that is sorting e-waste into proper areas for packaging must have knowledge of the components of the e-waste and the requirements of the contract recycler for packaging. Staff members who decide whether products are acceptable for reuse must have some technical knowledge to make this determination.

Training should be specific for each task. For instance, if a volunteer staff person is assigned for placing traffic flow markers and signage, that staff person will need to be trained (using the site map) on traffic flow. Similarly, if volunteer staff will be used to check in participants and screen materials, they will need to be trained on the type of materials that are acceptable at the event and on what to tell residents if they bring a product that is not acceptable.

Individual training sheets for each job function are good tools. The training sheets would contain details about the job expectations as well as potential hazards or possible injuries and how to avoid them. The staff person would be expected to review and sign the training sheet and return it to the program coordinator. Remember that a training sheet does not replace on-site walkthroughs and explanations of the work. Written training should be a supplement, not a replacement for on-site instruction. A sample training sheet is attached on the following pages.

Once you have determined the staff needs for your event, you will want to begin selecting staff. This may involve advertising for volunteers, requesting help from departmental staff and from staff in other departments, and talking with the selected recycler to determine what staff the recycler may provide. Staff workers should be notified well in advance of the date and time of the event so they can schedule to be there. Most staff training will be done on the day of the event, though providing written materials to staff in advance would be helpful.

## Job Safety Analysis

(Training information sheet provided by Riverside County Waste Management.)

JSA #: 15

Origination Date: May 10 2002

Job Description: Hazard Categorization

Last Revision Date: June 1 2003

Job Location: CAF

Positions Performing Job: Labor, Maintenance Construction, Crew Leaders

Evaluator: \_\_\_\_\_

New \_\_\_\_\_ Revised \_\_\_\_\_

Reviewed by Safety Officer: \_\_\_\_\_

Date: \_\_\_\_\_

PROJECT/JOB	BASIC PROJECT STEPS	EXISTING and POTENTIAL HAZARDS	RECOMMENDED CORRECTIVE MEASURES
<b>CRT Disassembling</b>  <b>Note!</b> <b>Read and sign attached CRT management documents</b>	<p>Customers arriving to the landfills are expected to unload all CRTs in a manor that prevents breaking.</p> <p>Once the CRT units are unloaded, employees performing CRT disassembling should:</p> <p>Cut the CRT electrical cord and place it in the wire drum.</p> <p>Place the CRT unit on the disassembling tarp/liner screen down.</p> <p>Remove the back cover of the CRT unit.</p> <p>Cut wires connected to the electron gun</p> <p>Remove copper yoke</p> <p>Remove four CRT tube mounting bolts</p> <p>Remove CRT tube, place in CRT tube box</p> <p>Remove all electronic green boards and power supplies, place in green board box.</p> <p>Place all metals in metal bin.</p> <p>Only wood and plastic cases may be disposed of.</p>	<p>Possible back injuries from lifting</p> <p>Possible trip and fall Injuries</p> <p>Possible cuts and lacerations from glass and metal</p> <p>Possible lead exposure from crushed glass</p> <p>Possible eye injuries</p>	<p>Use proper lifting Techniques. All console and &gt;25" CRTs require two persons to lift.</p> <p>Keep CRT area clean and orderly; keep serves level, keep walkways clear. Use leather gloves at all times, clean up broken glass as soon as it breaks.</p> <p>Do not break glass; clean up glass in a manor that will not create dust. Use safety glasses at all times.</p> <p>All new employees shall take part in initial training and annual review of the initial training.</p>

### Personal Protection Equipment Required or Recommended

Safety Glasses, Leather Gloves, Work Boots, Long Pants.

### Special / Primary Hazard

Leaded Glass, Lead Exposure, Cuts, Scrapes, Lifting/Back Injuries.

## Regulatory Requirements

### 66273.81. Prohibitions.

A CRT material handler is:

- (a) Prohibited from disposing of the CRT material; and
- (b) Prohibited from diluting or treating the CRT material, unless the handler is responding to a release as provided in section 66273.87 or the handler is managing specific wastes as provided in section 66273.83.

NOTE: Authority cited: Sections 25141, 25150, 25150.6 and 58012, Health and Safety Code. Reference: Sections 25141, 25150 and 25159.5, Health and Safety Code.

### 66273.83. Waste Management.

#### (a) Containment.

A CRT material handler shall manage CRT materials in a manner that prevents release of any CRT material or component of a CRT material to the environment, as follows:

- (1) A CRT material handler shall contain any CRT materials in containers or packages that are structurally sound, adequate to prevent breakage, and compatible with the contents of the container (CRTs, CRT devices and CRT glass). Such containers and packages shall lack evidence of leakage, spillage or damage that could cause leakage under reasonably foreseeable conditions. A CRT material handler who manages whole CRT devices in a manner that prevents breakage of the CRT and release of CRT glass (e.g., shrink-wrapped on a pallet) shall be considered to comply with this requirement.
- (2) A CRT material handler shall immediately clean up and place in a container any CRTs, CRT devices and CRT glass that is broken and shall place in a container any CRTs, CRT devices and CRT glass that shows evidence of breakage, leakage, or damage that could cause the release of lead or other hazardous constituents to the environment. Containers shall be structurally sound, and compatible with the contents of the container (CRTs, CRT devices and CRT glass) and shall lack evidence of leakage, spillage or damage that could cause the release of glass or other hazardous constituents to the environment under reasonably foreseeable conditions.

#### (b) CRT removal.

- (1) A CRT material handler may remove CRTs from CRT devices provided the handler:
  - (A) Removes the CRTs in a manner designed to prevent breakage of the CRTs;
  - (B) Removes the CRTs only over or in a containment device (e.g., a tray, a box, or an enclosed machine) sufficient in size and construction to contain any CRT glass that may be released in the event of breakage;
  - (C) Ensures that persons removing CRTs are thoroughly familiar with the techniques and safety precautions required to safely remove CRTs;
  - (D) Packages the removed CRTs in a container with sufficient packing materials to prevent breakage during handling, storage and transportation.

- (2) A CRT material handler who removes CRTs from CRT devices shall determine whether any of the remaining portion of the CRT device or any other waste generated during the removal process exhibits any characteristic of a hazardous waste identified in article 3 of chapter 11 and, if so, shall manage the hazardous waste in compliance with all applicable requirements of this division.

### 66273.86. Employee Training.

- (a) A CRT material handler shall inform all employees who handle or have responsibility for managing CRT material of the proper handling and emergency procedures appropriate for the waste handled at the facility.
- (b) Employees who manage or handle waste CRT materials shall receive initial training on:
  - (1) the hazards associated with handling CRT materials (i.e., leaded glass);
  - (2) the requirements contained in this chapter; and
  - (3) the proper procedures for responding to and managing releases of CRT glass.

- (c) Employees shall take part in an annual review of the initial training required in subsection (b) of this section.
- (d) The CRT material handler shall maintain records of employee training received under subsection (b) of this section for at least three years from the date the employee last worked at the facility. Personnel training records may accompany personnel transferred within the same company.

NOTE: Authority cited: Sections 25141, 25150, 25150.6 and 58012, Health and Safety Code. Reference: Sections 25141, 25150 and 25159.5, Health and Safety Code.

### 66273.87. Response to Releases.

- (a) A CRT material handler shall immediately contain all releases of CRT material and residues from CRT material.
- (b) A CRT material handler shall determine whether any material resulting from a release is hazardous waste and, if so, shall manage the hazardous waste in compliance with all applicable requirements of this division. The CRT material handler is considered the generator of material resulting from a release, and shall manage it in compliance with chapter 12.
- (c) Waste consisting only of residues of leaking, broken, or otherwise damaged

CRT material may be managed as universal waste provided that the leaking, broken, or otherwise damaged universal waste is repackaged according to the standards of section 66273.83.

NOTE: Authority cited: Sections 25141, 25150, 25150.6 and 58012, Health and Safety Code. Reference: Sections 25141, 25150 and 25159.5, Health and Safety Code.

EMPLOYEE SIGNATURE \_\_\_\_\_ DATE \_\_\_\_\_

#### 4. Determine Equipment Needs

Equipment needs for the event will vary depending on the agreement with the materials recycler you have chosen. Often the recycler will provide all or some equipment as well as staff. Other times the jurisdiction can save money by using their organization's own equipment.

The following equipment should be among that considered for the event:

- External communication system immediately available and capable of summoning emergency personnel.
- Internal communication system capable of relaying emergency information to all personnel.
- Emergency contact information (local fire/police/ambulance; site owner; contractor).
- Fire extinguishers.
- Folding tables (number depending on staging).
- Pallets/gaylord boxes.
- Forklifts and pallet jacks to move pallets or gaylord boxes.
- Stretch film.
- Labeling supplies.
- Rechargeable battery recycling containers.
- Tents or canopies.
- Chairs/benches/stools for event staff.
- Garbage and recycling containers.
- Signage.
- Saw horse/barricades to direct traffic.
- Duct tape.
- Traffic cones.
- Clipboards with attached pens.
- Receipt book.
- If collecting fees, something to collect money in/make change.
- Food and water for site workers.
- Camera (and someone assigned to take pictures).
- Name tags for event staff.
- Portable toilets.
- Shovels and brooms.
- Extension cords.
- Educational brochures and/or questionnaires.

Personal protective equipment (PPE) for event staff includes safety glasses, apron or coveralls, gloves, steel-toed boots, back-brace (optional), safety vests, first aid kits, and an eye wash station.

Well in advance of the event, you will want to determine where you will purchase or borrow equipment. A good planning tool would be a simple equipment checklist to make sure all equipment will be there on the day of the event. This checklist also provides the data needed to determine the costs and can be used to plan equipment needs for subsequent events. Knowing the actual costs and how they compared to estimates will help in refining the budget for the next event.

**Table 6. Equipment Checklist**

Equipment	Purchased from	Cost	Borrowed from	Date ordered/ confirmed
Fire Extinguishers			On-site	02/03/04
Name tags	Office Depot	\$14.95		02/05/03
Portable toilets	XYZ Company	\$135.00		03/07/04

Keep all the receipts for your files. If equipment is scheduled for delivery on the event day, make sure to bring the vendor's paperwork with date and time of delivery, costs and other pertinent details. Also, you will want an event day contact from the equipment provider's company in case the equipment doesn't show up.

## **5. Estimate Participation and Costs**

Household hazardous waste collection events are excellent models to follow in estimating participation and costs of e-waste collection events. These programs have operated for a number of years and have valuable experience and data available to aid in planning an e-waste event.

The first step in estimating costs is to estimate levels of participation. This will depend on the types of materials collected, the extent of your promotion or advertising of the event, who is going to participate in the event, the location, and whether a fee is charged. However, even when these factors change, participation in HHW collection events will generally range from 1–3 percent of the target audience, although occasionally events draw up to 6–8 percent. A good number to use to estimate participation at your e-waste event would be 2 percent of your target audience. For instance, if your event is for residents only and the population of your jurisdiction is 100,000 people, you would estimate that 2,000 people would participate in your event.

Similar events held elsewhere in the country have drawn an average of 2.5 people per car. Therefore, in our hypothetical event of 2,000 people participating, we could expect 800 cars.

Next to be determined is the quantity of materials to expect and what types of e-waste products would be brought in. Your recycler's contractor would be very helpful in providing this type of information, and published studies will show useful averages.

United States Environmental Protection Agency Region VIII, with the Colorado Governor's Office of Energy Management and Conservation and EcoCycle, Inc., published an e-waste event planning guide based on the results of six one-day events held in 2001. Results of these Colorado events are presented for planning purposes.

At these events, the following is the average weight of materials collected per car:

- 94 pounds if only computer equipment is collected.
- 118 pounds if all electronic products are collected.
- 3.6 pieces of equipment.

The average type of materials presented in the same study show the following:

- 44 percent monitors.
- 32 percent CPU towers.
- 10 percent printers.
- 1 percent laptops
- 13 percent other.
- Less than 3 percent Pentium grade or newer (usually the types wanted for reuse).



These statistics can be used to help you estimate the participation and types and quantities of e-waste expected at your collection event. In addition to contractor costs for recycling and transportation of the wastes anticipated, you will want to consider staffing costs for planning, completing the request for proposal and contractor selection, developing advertising and outreach, and working at the event site. Other costs may include equipment, supplies, packaging materials, insurance, and associated site costs.

Most waste management programs evaluate costs as a dollars-per-ton or dollars-per-car figure. Currently, the costs for e-waste management programs are all over the board. This is due to the relative newness of these types of events and the different ways in which different jurisdictions may calculate these numbers. Part of the difference in reported costs will be due to an organization's desire and ability to capture real costs. For instance, if staffing or publicity is shared with another program, are those costs absorbed by the existing program or allocated to the e-waste program?

As e-waste programs mature, we will want to be able to compare actual costs of the different program models to design more cost-effective programs in the future. The National Electronics Product Stewardship Initiative (NEPSI) is working on a project to standardize data collection to facilitate this kind of comparison. Forms developed for this project and may be accessed at [www.ergweb.com/nepsi/default.html](http://www.ergweb.com/nepsi/default.html).

**Table 7. Cost and Participation Worksheet**

	<b>Estimated Participation</b>	
1	Population of target audience	100,000 population
2	2 percent average participation (Step 1 x .02)	2,000 estimated participants
3	2.5 persons per car (Step 2 divided by 2.5)	800 estimated vehicles
4	94 pounds per car (Step 3 x 94)	75,200 pounds collected at event
	<b>Estimated Costs</b>	
1	\$.15 per pound recycling costs (Step 4 above x .15) (actual number provided by recycler)	\$11,280
2	Transportation costs (if not included in recycling costs)	
3	Advertising/promotion	
4	Event planning	
5	Recycler RFP preparation	
6	Site	
7	Event staff	
8	Equipment and supplies	
9	Packing materials	
	Total Costs	(add all figures)
	<b>Estimated Revenue</b>	
1	Participant fees (amount x est. number of cars above)	
2	Materials revenue (amt. x total pounds collected above) (if not included in recycler contract costs)	
	<b>Total Net Costs</b>	Total Costs minus Estimated Revenue

If the total cost exceeds your funding allocation, you need to reconsider the program plan. There are a number of ways to control program cost, such as:

- Smaller target audience.
- Limit types of electronic equipment accepted.
- Limit quantities of waste per participant.
- Charge a higher fee for wastes.
- Limit the collection hours.
- Do less outreach and advertising.
- Solicit volunteers to augment paid staff (environmental clubs, scouts, etc.).
- Find a sponsor/partner.

## ***Determine Data Collection and Reporting Requirements***

While planning an e-waste collection event, you should determine the information you will want to collect. By planning in advance, you will be able to develop the tools necessary to capture the appropriate data during the event. Considerations for data to collect include:

### **1. State Reporting Requirements**

Beginning on February 1, 2004, anyone who accepts more than five CRTs, CRT devices, or more than 100 kilograms of CRT glass per calendar year will be required to report information to the Department of Toxic Substances Control (DTSC). The information reported must include:

- The name and mailing address of the material handler (your jurisdiction).
- The name and business telephone of the person at the site who should be contacted regarding e-waste management activities.
- The address or physical location of the activities (including county).
- The total quantity of CRTs and CRT devices (count) handled the previous year.
- The total quantity of CRT glass (weight) handled the previous year.
- A list showing name, address, and phone number of each location that CRTs or CRT devices were shipped to during the previous year and total count to each location.
- A list showing name, address, and phone number of each location that CRT glass was shipped to during the previous year and total weight to each location.

All of the documentation and records used to meet these reporting requirements must be maintained for three years. This includes bills of lading, invoices, logs (or manifests), receipts, dates of collection, names and addresses of handlers, names and addresses where materials are shipped, and quantities (count or weight).

### **2. Management of Recyclers' Contract**

In addition to documenting State reporting requirements, you will want to keep records of quantities of materials collected as a tool to manage your recyclers' contract. When writing the contract for your recycler, you should keep in mind the State reporting requirements so you can capture data for your recycler and the State in the same way.

Your recyclers' contract will contain requirements for the recycler to report to you the final destination of the materials (if different from the contract holder) and quantities recycled. The data you gather at the time of the event will be beneficial in double-checking the data sent to you by the recycler.

### **3. Program Planning**

You will be able to use your own data to plan for future events, rather than estimates from other programs. As awareness about the e-waste issue increases, expect the participation rates and quantity of materials to continue to increase.

### **4. Program Evaluation and Improvement**

Even the best-planned events can include unexpected challenges, allowing you to learn from experience and make adjustments for future events. Information from surveys of both participants and event staff will be invaluable in helping you to avoid the same pitfalls at the next event.

## 5. Reporting Results

Many people will be interested in the results of your event, including those within your jurisdiction and peers in other communities. Your experience will provide invaluable information to anyone planning an e-waste collection event.

Reporting event results to the public is an educational opportunity that reinforces the importance of e-waste recycling and provides positive feedback to participants. Residents need to know that the cumulative results of individual actions are making a significant difference.

Also your event partners will want to hear program results and may even want to contribute to your data. For instance, if you partner with a retailer of electronic products, they may be able to determine if their sales increased from advertising they received by partnering in the event.

## 6. Determining the Best/Most Effective Outreach

You will want to gather data at your event to determine which of the public outreach media selected reached the most participants and what in your public outreach campaign convinced them to come. You may find that the most expensive public outreach vehicle was less effective than lower-cost methods. For your next event, you may choose to eliminate the expensive outreach.

# Data Collection and Program Evaluation

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Evaluation is important to the continued success of any e-waste collection program, whether it is a one-time event or an ongoing, regularly scheduled program. Evaluation will help you to determine if you met your program goals and serve as a guide to decision making. An evaluation pinpoints strengths and weaknesses and identifies what is working and what is not. When properly planned and conducted, program evaluation is a powerful tool to build solid programs. It can also supply the documentation necessary to secure funding in an unpredictable financial environment.

Successful program evaluation takes good planning, realistic goals, and measurable objectives. To be effective, program evaluation design should be initiated in the planning stage of the program. Give careful consideration to the purpose of the evaluation, available resources, and reporting deadlines. This section will examine the steps to planning the evaluation, collecting the data, and preparing project reports.

An evaluation plan should specify the following:

- Responsibility for the design, implementation, and reporting.
- Aspects of the program to be evaluated.
- Data and collection techniques.
- Evaluation and reporting.

## ***Responsibility for the Design, Implementation, and Reporting***

Planning an evaluation begins with identifying the people who will be responsible for the design, conduct, and report of the evaluation. Responsibilities should be agreed upon at the beginning of the evaluation planning. One person should be responsible for the overall management of the evaluation. Ideally, a team of people would know about the evaluation planning process and be knowledgeable about the participants and the program to be measured.

The evaluation team should seek technical advice, support, and/or training when necessary. Determining what information will be needed to make decisions and selecting evaluation methodologies can be overwhelming. Evaluating programs may be difficult for staff and stakeholders when they are directly responsible for a program's outcome. An external evaluator can function as an objective third party or act as a consultant to an evaluation led by a staff member. An outside evaluator can provide expertise, guidance, and impartiality, thereby enhancing the credibility of the evaluation.

The interests, expectations, and priorities of stakeholders should be assessed at the outset of the evaluation. Stakeholders may want to assist in deciding what aspects of the program should be evaluated. Evaluation requires resources, and staffing and associated costs should be included in the budget. Initially some may resist program evaluation because of the perception of creating additional work with no beneficial results. Inviting staff and other stakeholder input will help to overcome these objections and build support for the implementation of the evaluation.

### ***Aspects of the Program to Evaluate***

Evaluations generally provide information about the program and confirm informal beliefs about the program performance. Potential uses for evaluation information include program improvement, policy development, accountability, public relations, and justification for program continuation.

Before you design evaluation tools, you need to determine the questions to be answered by the evaluation and how the information will be used. All stakeholders in the process should be made aware of the planned uses of the data prior to development of collection strategies. Considerations for evaluation may include:

- Did the event accomplish the goals identified for the program?
- Were the costs of the event equal to or less than estimated?
- Was the site adequate for the event?
- Was setup of the event completed in time?
- Was participation at the event as anticipated?
- Were there any special events or circumstances that affected overall participation?
- Were participants satisfied with the service provided at the event?
- What outreach method was most effective?
- Did the recycling contractor provide the expected service?
- Were event workers properly trained?
- Was the event injury- and accident-free?
- What quantity of materials and program costs should you expect at future events?
- What did you learn, and what advice would you give to someone else running an e-waste program?

### ***Data and Collection Techniques***

Evaluation should include information (quantitative, qualitative, or both) gathered from a variety of sources with varying perspectives. The most common data collection mechanism is an on-site participant survey. Alternative data sources could include observations, testimonials, customer complaints, photos or videos, and exit interviews.

Considerations for data collection should start with the information that is required for State-reporting purposes as previously described. Other useful data may include the number of participants, the percentage of the target population served, the quantities of materials collected,

the percentages of e-waste collected by product type, the itemized total costs, the cost per participant, and the waste management cost per pound.

You may want to collect data from participants to determine how they heard of the event, whether they would be willing to pay a fee for recycling their electronic products, or other community-specific information. A separate questionnaire could be developed for event staff and stakeholders to evaluate what worked and what didn't work, with suggestions for changes next time.

Each information collection strategy will generate data that must be compiled and made ready for analysis. The data analysis procedure will depend on the questions and the type of information collected. It may be necessary to obtain outside assistance at this stage of the planning to ensure the validity of evaluation results.

If evaluation resources are limited, select an on-site survey that is designed to be short and simple. Questions should lend themselves to yes or no answers or multiple choice (rather than open-ended questions) so the data is easy to compile.

## ***Evaluation and Reporting***

Evaluation is different than data gathering. The collected data is compiled and prepared for analysis. Evaluation involves interpretation and judgment and may result in a development of recommendations or options for future actions that will be included in the program report.

An evaluation report should begin with an executive summary that provides an overview of the program, the purpose of the evaluation, information sources, and major findings and recommendations. The summary should be clear, complete, accurate, and objective. Some of your audience will be too busy to read further.

The body of the program report should include a description of the program, goals and objectives, and expected accomplishments if the goals and objectives were met. Follow the background information with an explanation of why the evaluation was done and what you hoped to learn from it. You can discuss the methods used to collect and analyze the data and the results of the evaluation. The results section should organize the data in understandable form through use of tables, charts, or graphs. Based on the evaluation results, recommendations and conclusions may be developed. A discussion of program strengths and weaknesses can point to recommendations for future program improvements.

Some reports include a cost and benefit section that discusses the budget and the benefits derived from the program. This section can provide an opportunity to justify your program budget and reasons for continuing the project.

Finally, the report would contain appendices with any technical information and data for those who are interested.

The distribution of project report and evaluation findings should be done soon after the event, while interest is high. Share your report with all that may have an interest, including staff, volunteers, community supporters, funders, elected officials, and your target population.

# Public Education and Outreach

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Development of an effective public education and outreach campaign takes thought and planning. This section will address:

- Components of a public education and outreach campaign.
- Designing an e-waste public education and outreach campaign.
- Special considerations for an e-waste collection event.
- Follow-up.

## ***Components of a Public Education and Outreach Campaign***

The basic and necessary components of a public education and outreach campaign need to answer all of the following questions:

- Who
- What
- When
- Where
- Why
- How much

### **1. Who Will Participate?**

The e-waste collection event may be for residents only, or it may include small businesses or schools. The event could be for only those residents and/or small businesses in your community, or it may be a regional program including residents and/or small businesses for several jurisdictions in a geographic area. Determination of who will participate in the event is a crucial first step, since it will affect the costs of the public education and outreach as well as the operational costs of the event. This determination will go hand-in-hand with the planning phase of the program and will require input from multiple stakeholders.

In determining who will participate, keep in mind how you will communicate the event to the identified participants. There may be a segment of the population that you would like to include as participants, but reaching them with a public education and outreach campaign could be difficult and expensive (for example, individual tenants in an apartment complex). You may not want to include these types of participants in the initial event, but wait until the later events when the planning and operations of the events are running more smoothly and can be expanded.

A large part of determining the target audience for public education and outreach will depend on the number of participants that can be served at the event. This depends on the size of the site, the number of event staff available, and budget for the event. This is why the person in charge of public education must work closely with the person in charge of planning and operations.

### **2. Who Is Holding the Upcoming E-Waste Event?**

Your public education materials should clearly state who is holding the e-waste event. This would include the name of the agency and the telephone number people should call if they have questions.

Also, if you have partners or sponsors for the event, you would want to include them as well. You may even be able to have some of the costs of your public education campaign offset by contributions from your partners if you include their names or logos on your public education materials.

### **3. What Type of Products Will Be Accepted?**

What types of electronic products will be accepted at the event? The education and outreach materials need to be very clear on the types of products accepted. Even when you believe you have been very clear, invariably participants will bring in items that are not accepted. So you don't want to add to this problem by being vague or unclear in your education materials in the beginning.

The types of products that will be accepted at the event are going to be dictated by the contract or agreement reached with the recycler of the materials. This is a "which-comes-first" situation. You will want to know what types of materials you would like to accept at events before issuing a request for proposals (RFP) for a recycler. However, you may need to compromise on the types of materials accepted due to various reasons during the RFP and contract development process with a recycler. Therefore, public education personnel and planning/operations personnel must work closely in this determination.

Once the types of materials to be collected are confirmed, you will want to determine the best and most clear way of communicating this to the public. Graphics are always good, but sometimes they are more expensive to develop and produce. Identifying the product by name may need to be supported by additional descriptive text. Whatever method you choose to use should be clearly understood by the general public. Stay away from industry-specific terminology that may not be universally understood.

Sometimes public education materials will include what is not accepted as well as what is accepted. If you decide to include what will not be accepted at the event, be very careful that it is clearly presented as an unacceptable waste type. Participants may skim the list of materials and not distinguish between acceptable and unacceptable materials unless the piece is very clear.

### **4. When Will the Event Take Place?**

One of the primary purposes of public education materials is to let participants know when the event is to take place. This information should include the day of the week, the month and date, and the times of the event. You may want to stress that participants will not be allowed to drop off wastes before the start time or after the closing time of the event. This may help to discourage participants from showing up early expecting to beat the crowds or long lines. The day of the event will be extremely busy (site setup and staff training) that you will not want to deal with early arrivals.

### **5. Where Is the Location?**

The location of the event also is important information. Ideally you have chosen a site familiar to participants, with easy access from major streets in your jurisdiction. You will also want to provide easy-to-follow directions and a simple map to follow. Provide both directions and a map for participants and point out landmarks as well as street names.

### **6. Why Is E-Waste Recycling Necessary?**

As the person responsible for developing an e-waste collection program and the corresponding public outreach, you are most likely a technical expert. This means that you have a wealth of information and knowledge on this subject. But the average person (whom you are addressing in your public outreach campaign) will be confused and overwhelmed if bombarded with all this information. It is important to condense this information into a few succinct, vital, and understandable points that will catch the attention of the recipient and compel them to dispose of their obsolete e-waste products the right way. There are many models in the recycling industry to



follow. This type of awareness education was used when recycling of glass, plastic, and metals started and for the correct disposal of household hazardous waste. The message is similar for e-waste. Finding previously successful public outreach campaigns to use as models is a good way to begin the development of your e-waste outreach campaign.

## **7. How Much E-Waste is Each Participant Allowed to Bring?**

You may decide to limit the quantity of e-waste each participant is allowed to bring to better control the total quantity expected at an event. As discussed in the planning section, you can make estimates about the number of participants and the quantity of e-waste per participant, but these are only estimates. If actual e-waste products brought in exceed your estimates, you may have more materials than you can handle or afford under the terms of the recycler's contract. On the other hand, if fewer materials are brought in than estimated, you may end up with the total cost per pound for handling the materials being exorbitant. One of the ways to help balance these possibilities is to have a maximum quantity of items per participant. This would need to be explained very carefully in the public education materials. For instance, many participants may think that a computer consists of all components—monitor, hard drive, printer and keyboard—whereas you may consider these four different items. Be sure to explain this carefully in the outreach materials when discussing quantities.

If you have decided to charge a fee for participants, you will want to include the amount of the fee in the public education materials. The least confusing fee structure is to charge the same fee per item, regardless of the type of product, though this may turn out to be unfair to some participants. If you charge a fee per item type, be sure to include a full chart showing the charge for each product type.

## ***Designing an E-Waste Public Education and Outreach Campaign***

### **1. Determine Your Target Audience**

Your intended target audience will receive your advertising for the event. The size of your target audience is dependent on how many participants your event can handle, based on the size of the site and your budget.

### **2. Determine Types of Media to Consider in Advertising an E-Waste Collection Event**

You want your public education campaign to be comprehensive and repetitive (using as many different types of media as possible), yet within your budget. Therefore, many programs strive to use a combination of paid and free advertising to maximize media coverage.

You will want the media to reach only your target audience. The challenge is reaching your target audience without creating service demand outside your jurisdiction. Radio may not work as a medium because many outside of your target audience will hear the message. If your event can handle 2 percent of your entire community, a direct mail advertisement to all households could be an effective media. You can target segments of your population by working with your solid waste hauler to deliver door hangers in certain areas of your city, or working with the post office to deliver to only certain areas. (Note: post offices can give you the location and number of households in each postal carrier route in your city. A postal carrier route is a group of households covered by one postal carrier; each postal carrier route has an identifying number. If you batch direct mail pieces in the correct numbers for each postal carrier route, and clearly mark the postal carrier route number, the post office will distribute just to those areas).

The types of media you may consider using in your public education campaign are:

- Website (your jurisdiction's website, including links to the California Integrated Waste

Management website).

- TV/radio (local public service announcements, news stations, council meetings).
- Newspaper stories, ads, and inserts.
- Bulk direct mail.
- Door hangers.
- Utility bill inserts.
- Handouts provided by garbage company or landfill.
- Community/neighborhood newsletters.
- Signs and posters at recycling center, grocery stores, libraries, and other public areas.
- Billboards.
- Banners at city hall, libraries, and other public areas.
- Handouts to students.
- Retailer displays (especially retailers that sell electronic products).
- Local business marquees.
- One-on-one personal contact.
- Speaking opportunities at local clubs, schools, or organizations.
- Payroll inserts.

In determining the types of media for your education campaign, consider cost (including hidden costs, like staff time for otherwise free advertising such as speaking events) and ensure that the chosen media is reaching only your target audience.

### **3. Develop a Slogan**

A catchy slogan or phrase that is easily remembered and associated with your program will help attract attention to your campaign. The public will remember a catchy slogan. Using the same slogan or phrase throughout all the public education distributed for your program will help to make sure your message is communicated. Though e-waste collection events are relatively new, several effective slogans have been developed. If you find one that your jurisdiction would like to use, you can contact the host jurisdiction to obtain permission to use their slogan. You may want to develop your own slogan that in some way represents your community; or use a slogan that is already identifiable with recycling in your community.

### **4. Design a Look**

As with a slogan, you will want all of your public education materials to have the same look. This is done through the use of colors and graphics. Remember that you want your public education message to draw the attention of those who normally see or hear hundreds of messages a day. Colors and graphics play a large role in accomplishing this.

Another way to draw attention to your message is through the size or shape of your public education piece. This is true especially for direct mail advertising. However, you will want to consider the cost of postage and production of direct mail pieces that are oversized or oddly cut.

### **5. Develop a Design and Text That Is Usable in Multiple Types of Media**

The best design can be easily transferable to multiple types of media. For instance, the same design could be used for a direct mail postcard, for a newspaper advertisement, or for a poster. The same message could be used in a public service announcement or in a radio advertisement. The more easily transferable your message is, the more cost-effective your overall campaign will be.

## **6. Develop a Timeline for Development and Distribution of Your Public Education and Outreach Materials**

The best way to develop a timeline is to start from the end and work backwards. For instance, if you want to send a direct mail advertisement, you will need to work backwards to account for the following:

- Time of mailing (allow at least a week).
- Time of production (the printer can tell you, but normally three or four weeks).
- Time for design (may want to allow a month).
- Time for purchase approval.

Carefully think through all the steps of developing your campaign and allow more than sufficient time for each step. Your timeline should allow for the unexpected and still make the targeted deadline for distribution of the materials.

You want to distribute outreach materials far enough in advance so people can schedule this activity, but not so far in advance that people will forget by the time the actual event arrives.

### ***Special Considerations in Education for an E-Waste Collection Event***

- You may consider doing a two-phase campaign. The first phase of the campaign would be designed to raise awareness of the issues associated with disposal of electronic products and education regarding the current or upcoming State laws regarding disposal of these products. This is a newly regulated waste stream in the State of California, and raising awareness about the issues may be a necessary first step in managing the waste stream.
- Once you start raising awareness of the issues, people will want a way to dispose of the products legally and safely. Therefore, you will want to have an infrastructure in place to handle the demand for service created by your message. You will want to conduct an awareness campaign early enough to raise awareness so your event is successful, but not so early that people have to wait to dispose of the products once they are aware of the issues.
- If you are adding e-waste to an existing waste collection infrastructure (such as household hazardous waste drop-off events or curbside), combining the advertising for the programs will make sense. However, do not do this in the initial stages of developing an e-waste program. The public needs to be educated regarding the unique issues surrounding this waste stream, and this education should be done on its own.

Developing a public education campaign for a one-day event can be labor-intensive and costly in terms of staff and production time. If future one-day events are held at the same location, you can reuse the design and information you developed by simply changing the date. However, be aware that advertising looks change. You will want to revisit your design periodically to ensure it is still fresh and attention-getting.

If you were developing a public education campaign for a permanent e-waste collection site, you could stagger the types of media you use throughout the year. For instance, start out with a multi-media campaign, but then plan newspaper and public service announcements one quarter, newspaper ads and direct mail another quarter, etc.

Incentives or giveaways often attract attention to your public education campaign and increase participation. If you have a partner or sponsor, you may be able to get them to offer discount coupons for participants. If you are charging fees for drop-off, you may offer free drop-off for the first several participants or randomly selected participants.

## 7. Follow-Up

In a separate section, data collection is discussed. Information collected from participant surveys will help you to evaluate the public education campaign and make refinements for future collection events. Other program data will be used to create reports about the event.

It is extremely important to tell the community about the event results. Information such as number of participants, pounds of e-waste materials collected, where and how materials were recycled, and similar information will provide yet another educational opportunity and encourage others to participate in future collection events.

# E-Waste Program Operations

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The operational steps and activities from the beginning to the end of a one-day collection event are detailed below.

## ***Setting Up the Site***

The site will be set up using the site map developed during the project planning stages. Several event staff will be necessary to set up the site, but one person (most likely the program coordinator) should be designated to walk through the site and ensure that everything is set up properly.

The site setup should be completed well in advance of the time participants are expected to arrive. Therefore, you will want to set your event start time late enough to allow for site setup, but early enough to be convenient for participants. The most popular event times seem to be 9:00 a.m. to 2:00 p.m. This may change depending on the number of participants expected, the size of the site, and the number of event staff available.

Most likely you will start setting up the site at least two hours before the event is scheduled to begin. Remember to allow more time than you expect you will need. Better to have the site set up early than to have setup not completed when participants start arriving.

Expect participants to arrive early. Some programs start the event 30 minutes to one hour before the advertised starting time to accommodate early birds.

## ***Training Event Staff***

If this is the first e-waste event your jurisdiction has conducted, event staff may need more time to train. Most likely the experience level of the event staff will vary. That is a good reason to have training materials specific to each position prepared ahead of time. These training materials should include all the tasks of that position and, most importantly, the hazards or potential dangers inherent in that position. Each staff person will be asked to sign the training form after reviewing it and understanding all the information. Distributing the materials before the event date could save valuable time.

The main focus of the staff training on the day of the event should be on-site-specific details and safety. Even the most experienced of your event staff may not have worked this specific site or an event setup in this specific way. For this reason, all event staff should be required to attend the training session, regardless of level of experience.

A large blowup of the site map would be a valuable tool for this training. Use the map to point out the flow of traffic and remind event staff not to cross the flow of traffic or stand between cars in line. Also use the site map to point out the various areas on the site (check-in, unloading, sorting, packaging), amenities (restroom, water, food) and necessary emergency information

(telephone, first-aid kit, site exits). Training should include what to do in case of an injury. The program coordinator should be aware that any injury beyond first aid (loss of mobility, taken from site by ambulance) must be reported to OSHA. Keep a list of emergency telephone numbers accessible at the event.

If possible, all event staff should be issued walkie-talkies for internal communication and trained on how to use them. If budget does not permit this, make sure one person in each area of the site (entrance, unloading, and exit) or at least 2–3 “roving” staff (including the program coordinator) has a radio so that internal communications flow smoothly.

The training time before the event is also a good time to remind the staff of the rotation or shift changes. Rotating staff is critical to prevent injuries. Other safety considerations that can be covered during this training time are:

- Review proper lifting techniques.
- Remind staff of two-team lifting for large components.
- Lead staff through simple stretching exercises.
- Remind staff to drink plenty of water.
- Distribute personal protective equipment (PPE).
- Remind staff of cleanup procedures in case of broken glass.

If the event is large, you may want to consider training staff in smaller groups made up of staff with similar types of jobs or safety liabilities. For an event with 25–30 staff, training can be conducted in approximately 30 minutes and can most likely be done while the site is being set up (assuming the site setup staff have already been trained or will be trained after setup). Make sure that an event staff person is appointed to deal with queuing traffic before the event starts. This person will also need to be trained separately from the other event staff.

Whatever training configuration you use, the training should be complete and all staff in place at least 15 minutes before the event begins. Also, keep in mind that training will need to be repeated for the shift change or for the event staff that will rotate in to relieve other staff.

## ***Checking in Participants***

Once the event begins, you will want at least one staff person stationed inside the entrance to the site (and before the unloading areas) to greet participants. Exactly where this person is stationed will depend on your site and the traffic queuing area.

A primary function of the greeter is to verify the participants’ eligibility to bring e-waste to the event. The required eligibility should be publicized with the outreach materials so that all participants bring the proper identification. Normally, this would be a driver’s license or utility bill or other document that proves the participant is a resident of the sponsoring jurisdiction.

The greeter should also look at the e-waste products and identify any that are not being accepted at the event. In order to do this, the greeter must be trained to identify the materials. The greeter should also know what to tell participants and be prepared to provide a list of alternative drop-off or disposal sites.

If you have decided to inventory wastes from each car, the greeter may be the logical person to do this task. The greeter is already visually inspecting the loads to ensure that only acceptable products are being brought in. Whether the inventory list is completed by the greeter or elsewhere will depend on the size of your event, the traffic queuing area and other factors. If the traffic queuing area is short, the greeter may not have time to do an inventory without backing up regular street traffic.

Another function the greeter could perform is handing the participants informational brochures and the event survey. Participants will find completing the survey easier if you provide clipboards and pencils. (Note: Be prepared to have someone collect the clipboard after the unloading point and return them to the greeter.) At this time the greeter could also distribute informational brochures. The participant could be filling out the questionnaire and reviewing the informational brochures while waiting in line and/or having materials off-loaded.

The greeter's responsibility is to control the traffic flow into the unloading area by letting cars continue only when there is enough room to proceed to the off-loading area. You may provide more than one lane for off-loading (which is preferable if the size of the site permits) or the participant may need to be directed into a separate off-loading area for special needs such as large loads.

## ***Collecting Fees***

If your jurisdiction has decided to collect fees to help offset the cost of the program, a number of factors come into play. You will need to decide what the fees will be and how the fees will be collected. You may wish to only accept checks. However, to make the event more convenient for participants, you may choose to accept check or cash. If cash is being accepted, the cashier must be ready to provide change. Whatever the decision, the fees and the method of payment should be well publicized in advance of the event.

The cashier should have a lockable cash box that will be emptied periodically throughout the event by the program coordinator. Also, you need to take care in assigning the person who will collect the fees. You will want someone who is responsible and trustworthy, preferably an employee of your jurisdiction.

You need to decide where the fees will be collected. If the greeter completes the inventory list, the cashier could be the next stop—between the greeter and the off-loading area. The cashier would determine the total fee and collect the money from the participant.

If the traffic queue area was small and collecting fees would hold up traffic, you could have the cashier at the end of the off-loading area. One advantage of collecting fees after off-loading is that if for any reason a product is not accepted, invoice adjustments could be made prior to payment.

If you are partnering with a nonprofit organization that will resell the usable products, participants may request a receipt indicating a charitable donation. Often the nonprofit organization may provide staff and issue appropriate receipts. Many jurisdictions have discovered that only a small portion of electronic products brought to these events are suitable for resale. You may want to hold a few events and gather data to determine whether enough reusable products are brought to the event to warrant setting up a process to handle them.

## ***Directing Exit Traffic/Collecting Paperwork***

Exit staff needs to be stationed after the unloading area to direct traffic off-site. Although traffic lanes should be clearly marked and easy to follow, there should be someone present to handle any confusion that may occur. This person will also collect the participant questionnaires.

## ***Unloading Materials***

The flow of materials, from unloading to sorting to packaging, is an important element of site design. The stations need to be as close together as possible to save time and exertion, yet far enough apart to allow for accumulation of products in any one area. The product flow will depend on the size of your site and the number of event staff you have. Whether you have one or more

unloading stations, participants must stay in line and not pass vehicles in front of them to proceed to another station or to the exit.

In many situations, only one unloading area is necessary. Unloaders would take all e-waste at one time and use carts to deliver waste to the appropriate sorting area. Depending on the rate of traffic flow and staffing level, unloaders may also be involved in preliminary sorting functions. If traffic flow increases, they would return to strictly unloading vehicles.

The recycler will have very definite requirements for the separation of the products. For a large event, consider multiple off-loading stations where each station receives only a certain type of product, for instance, one station offloads CPUs, another station unloads printers, another small electronic products, etc. Unloading by product type at a large event may expedite the sorting and packaging of materials.

If you are trying to reuse or donate any of the equipment, the unloading staff needs to be trained to identify the products that meet the reuse requirements. Or one expert could be assigned to rove throughout the unloading and sorting stations making this determination. You should designate a separate reuse storage area away from other functions.

If an inventory or invoice were completed at the entrance to the event, the staff unloading materials would want to double-check this list for accuracy. If any adjustments are to be made, this is the time to make them. Unloaders need to be familiar with the fee process and be able to direct the participant to receive a refund if required.

Because unloading cars is a strenuous job, particular care should be taken to avoid injuries. Precautions include special emphasis on proper lifting techniques, encouraging warm-up stretches and frequent rotation to less strenuous jobs.

## ***Sorting and Disassembling Materials***

Materials will be sorted according to the specifications of the contract with the recycler. The event staff should be trained to follow these guidelines specifically.

Sorters should be aware of how the packaging will be done, since this is a primary factor in improving event efficiency. For instance, products of the same type and/or size will be packaged together to maximize the amount of materials on a pallet without breakage. Therefore, sorters should think about how similar products will stack when staging products for packaging.

If sorters are isolating products that are reusable, an area must be designated for staging those products. The space designated for reusable products should be in a safe area to eliminate breakage and should be protected from the weather.

Sorting will be strenuous and physically demanding, and staff should be selected for this job accordingly. As with the staff unloading vehicles, sorters should be rotated or relieved more frequently than less strenuous staff positions.

The agreement with your recycler will determine how much product disassembly will be done on-site during the event. At most one-day events, no product disassembly is conducted. If time allows, staff could perform simple dismantling such as removing cords, batteries, or ink cartridges.

In contrast, at a permanent collection facility, the ability to store products can provide an opportunity to do some on-site disassembly and packaging of components. A permanent landfill-based program in Riverside County follows these steps to the disassembly on-site of CRTs:

- Cut the CRT electrical cord and place it in the wire drum.
- Place the CRT unit on the disassembling tarp/liner screen down.
- Remove the back cover of the CRT unit.
- Cut wires connected to the electron gun.
- Remove copper yoke.
- Remove four CRT tube mounting bolts.
- Remove CRT tube, place in CRT tube box.
- Remove all electronic green boards and power supplies, place in green board box.

Though this sounds difficult, the process can actually be done in very little time with well-trained staff and saves the jurisdiction money in the long run.

## ***Packaging and Labeling Materials***

Packaging of e-waste materials is usually done either on pallets or in gaylord boxes. Pallets are generally 48 x 48 in. Products of similar size should be stacked on the same pallet to ensure efficient stacking. Ideally, stacking can be done without space between products. This makes transporting more cost-effective because you are not wasting space in the truck.

As you begin to load a pallet with CRTs or other e-waste, it's a good idea to lay down a bottom layer of plastic shrink-wrap to catch any potential breakage. Items of similar size are placed on the pallet. Cardboard is placed between each layer of e-waste to increase the stability of the load. There will be plenty of cardboard on-site since participants tend to bring their materials for drop-off in cardboard boxes and do not want to take them away with them.

Computer monitors take the most care in packaging to ensure they remain intact and no breakage occurs. Monitors can be stacked on pallets in layers with 9–12 monitors per layer. As the pallet is stacked, each layer is shrink-wrapped to secure the stack. The shrink-wrap must be pulled as tightly as possible to avoid shifting of materials during transport. Generally, pallets are stacked to chest or shoulder height to maximize the amount of material that can be transported. Because pallets cannot be double-stacked, the height of the stack determines how much e-waste will fit in the truck.

While minimizing transportation costs by making sure the truck is full is important, pallets may be unstable if stacked too high or they have not been tightly wrapped. Unstable pallet loads can fall and injure staff. This potential risk needs to be covered in the training materials and during direct training.

According to an article in *Waste Age* magazine, one pallet can hold the following quantities:

- 27 14–15 in. monitors.
- 40 CPUs.
- 8–12 printers.
- 80–20 laptops.

Gaylord boxes are reusable corrugated shipping and storage boxes, typically 48 x 48 x 48 in. They are excellent shipping containers since they provide rigid sides (unlike shrink-wrapped materials). Gaylord boxes work well for materials that are not stackable, such as small electronic products.

Filling gaylord boxes can be difficult because the material has to be lifted up over the top of the container and placed down as far as the floor of the container. This will require special training of lifting and setting down techniques. Normally, taller people will be able to more easily set materials down safely in a gaylord box.



Once each pallet and/or box is loaded, a label needs to be placed visibly on the outside. Each label must contain the following information:

- Name and address of the material handler (your jurisdiction).
- Name and address of the destination facility (where material is going/your recycler).
- Quantity (count or weight) by material type.
- Date the shipment will leave the facility (which may be different than the event date).

You will want to record the count and/or weight of the material type in each container as they are labeled and loaded on the truck. Your record should be used to double-check the bill of lading and the contractor's invoice.

The full pallets and/or boxes will be loaded into trucks or roll-off containers with forklifts or pallet jacks. If loading is being done during the event, workers need to be aware of forklift traffic. You may want to stop participant traffic flow while the forklifts are moving waste and replacing pallets or boxes with empty containers.

If the materials aren't going to be picked up until a later date, you will need to arrange a place to store the pallets and boxes that is secure and protected from the weather.

## ***Breaking Down the Site***

Be certain to assign staff to assist with breaking down and cleaning up the site. Though this seems like an obvious task, event staff will not stick around to do this unless specifically designated to do so in advance. Since most collection events are long and the employees are tired by the end of the event, your breakdown staff should be people who arrive later in the event.

## ***Transporting Materials***

Under universal waste regulations, a hazardous waste manifest and transporter are not required. It is important that you ensure that the transport vehicles are in good condition, are well maintained, and have all current registrations, licensing, and insurance.

You should make sure that drivers for the trucks are licensed appropriately. Class C licenses are for passenger vehicles, vans, and small, non-commercial trucks.

Commercial truck drivers must hold a Class A or B license. Drivers must have a commercial drivers license if the vehicle:

- Has a gross vehicle weight rating (GVWR) of 26,001 pounds or more.
- Is designed, used, or maintained for carrying more than 10 passengers, including the driver.
- Tows a vehicle or trailer that has a GVWR of 10,001 pounds or more.
- Transports hazardous materials that require placards.
- Tows any combination of two trailers or vehicle and trailer (requires Class A).
- Commercial licenses are not valid without a current medical card. Any driving restrictions for that driver would be noted on the back of the medical card.

You are responsible for keeping your own records of the shipment and submitting annual reports to the Department of Toxic Substances Control beginning in February 2004. The shipment records include the bill of lading, invoice, log (or manifest), and receipts. These documents should contain the dates of shipment, date of receipt of shipment, name and address of your jurisdiction, and the destination and quantities (count or weight) shipped. These shipment records must be kept for three years.

Though your reporting responsibilities are fulfilled at this point, you should know the final destination and management methods of the materials you collected. The recycler is not the last step for your materials. You should know the final destination of your materials, because your jurisdiction is ultimately responsible for any environmental damage caused by your waste.

## What Happens to E-Waste

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This section will discuss how e-waste management fits into the waste management hierarchy and look at what happens to each of the materials.

One of the ongoing challenges in recycling any material involves determining if the material has enough value to justify the cost of collecting, transporting, processing, and marketing. To date, many dismantlers and scrap metal dealers have principally focused on large sources of electronic scrap and used equipment that can be obtained from manufacturing, government, and commercial sources.

Recycling of business electronic waste is profitable as compared to e-waste from residential collections. The cost of collection and transport of used PCs from commercial sources is significantly less than for the recovery of similar equipment from the residential sector. Additionally, business waste is likely to be newer, higher-value equipment that is available in larger consistent lots. Often businesses will contract with recyclers for asset management services where the business is paid a portion of the resale or recovery value of the equipment in exchange for environmentally sound management and data protection services.

Residential e-waste collection programs will probably not provide any net value for the program sponsor. Focus should be placed on environmentally sound management of wastes according the waste management hierarchy as described below.

### ***Waste Management Hierarchy***

When e-waste leaves the collection site, it may be transported to a consolidation center. A consolidation center provides opportunity to accumulate large volumes of waste, which may offer economies of scale to reduce transportation and recycling costs. While in the storage facility, equipment can be tested, evaluated, and diverted for reuse. Waste brokers buy and sell entire units or components before e-waste enters the recycling process.

#### **Reuse**

In the waste management hierarchy, the best management method is direct reuse, where someone else can use the electronic equipment without change. A very small percentage of residential electronic waste is likely to fall in this category because people tend to store old equipment for a couple of years before thinking about recycling.

Giving reusable equipment to nonprofits or schools can provide tax deductions to the donor and assist in bridging the digital divide. It is important to determine if the potential donation will be usable to the recipient and that they will have a mechanism to manage the equipment at the end of its extended life. Other issues concerning donations are software licensing and adequate removal of data to ensure donor privacy.

If reuse is to be a sustainable business operation, the revenue from computer resale must exceed the costs of collection, transportation, storage, testing, and refurbishment. The market for used computer equipment is very price-sensitive and in constant competition with declining prices and increasing performance of new electronic equipment.

## **Refurbish and Reuse**

Often electronic equipment can be refurbished by making minor repairs. Some charitable organizations have training programs for repairing and upgrading computers for resale. All personal computers are modular to some extent, that is, at least some parts can be replaced with the same parts or with upgraded parts. The useful life of a personal computer can be extended, but proper management at the end of its extended life is still an issue.

## **Component Recovery**

When repairing or refurbishing a computer is not economically feasible, some valuable components may be able to be reused. These parts include memory, disk drives, circuit boards, and microprocessor chips. Working cathode ray tubes from computer monitors may be sold and reused in the manufacture of televisions. Scrap metal such as cables containing copper and aluminum housings are also separated for recovery.

More value is recovered from the end-of-life electronic product with demanufacturing than would be recovered if the whole product were scrapped without disassembly. Demanufacturing, or disassembling of electronic equipment to recover working components, can require desoldering or use of simple hand tools. Traditionally this process has involved a high degree of manual labor for dismantling computers and sorting by material type. However, some companies are developing systems to automate the process.

## **Raw Material Recovery**

After the reusable parts of a computer are removed, a large variety of metals, plastics, and glass remain. To recover additional value, the equipment must be segregated into material type. Any hazardous components such as batteries or mercury-containing switches must be removed prior to further treatment, or the resulting mixture may all be hazardous waste. Unless the recycler processes batteries, mercury, leaded glass and other hazardous materials, downstream tracking for these materials is needed.

The remaining material is usually shredded or ground and further segregated and sorted by means of magnets, eddy currents, wind sifting, or similar techniques. Additionally, washing and other identification or separation may be used to prepare the material for the end market. These processes yield the following types of materials: iron, aluminum, copper, glass, plastics, ceramics, and composite metal granulates. Once a clean, high-quality stream of material is produced and consolidated and a customer is identified, the material is shipped and used to manufacture a new product. Recycling has not occurred until these final steps have been completed.

## **End Markets**

Metals are the only materials used in electronics for which cost-effective, high-volume recycle streams already exist. The infrastructure for recycling other materials contained in electronics is still being built.

Copper is used in conducting parts of all kinds, including cables and wires, transformer and motor windings, and inductors. It is a relatively valuable metal, and copper recovery from electronics parts often takes place at secondary copper smelting facilities. The smelting process can produce commercial grade copper from copper-bearing scrap.

For decades, the scrap metal industry has collected, dismantled, sorted, and processed materials containing metal. They can reclaim ferrous and non-ferrous metals, including steel, aluminum, and copper from computer cases and frames, wires, and cables. The fully separated metals and glass can be sent to various smelting plants to substitute for materials used in the smelting

process. Raw material recovery, for example, via smelting, often involves the generation of emissions or residues that require careful control in order to avoid adverse impacts on worker health and the environment.

Structural parts in electronic equipment such as enclosures, chassis, mechanical parts, and screws are made of common metals including steel, aluminum, and to a lesser extent, magnesium. These metals are often in alloys with other metals such as nickel or chrome. Their commercial value is generally low, and the success of recycling operations for these metals depends on cost-effective processing of high volumes of material. Metal bearing scrap is usually loaded into refining furnaces as a direct replacement for ores.

Circuit boards are considered hazardous waste because of the lead content in solder. They also contain copper on the electrical connections and enough precious metals to make material recovery desirable. Although the gold content of circuit boards is declining as manufacturers have developed techniques for applying thinner gold layers to contacts, precious metal recycling is still profitable.

Electronic scrap contains gold, silver, and palladium. The precious metals recovery industry has developed a number of refining processes to extract precious metals from scrap. For instance, a cyanide solution is often used to dissolve and extract exposed gold. Other techniques utilize electrolysis and roasting or smelting. A detailed discussion of the metal recovery processes can be found in an online article entitled “Metal Recovery from Circuit Boards,” <[www.geocities.com/ResearchTriangle/Lab/2277/pwbmet.html](http://www.geocities.com/ResearchTriangle/Lab/2277/pwbmet.html)>. Of course, proper disposal of potentially hazardous by-products is needed to alleviate future environmental liability.

CRTs are one of the few electronic waste components in which recycling costs exceed the commodity value. Markets for glass from CRTs are limited. A typical CRT contains between 4–8 pounds of lead, which causes it to fail federal and California hazardous waste tests. Usually, CRT recyclers will grind the glass and send the leaded glass cullet to be used in the manufacture of new CRTs or to be used as a fluxing agent in the lead smelting process. Industry is continuing to look for new markets and manufacturing processes to utilize the leaded glass cullet.

Finding markets for postconsumer plastic is one of the industry’s biggest challenges. Consumer electronics contain a number of types of plastic resins. MBA Polymers in Richmond, California, has been working in public-private partnerships to develop equipment to assist in segregating the various types of plastics. Pure plastic resins can be recovered from municipally collected electrical and electronics waste. However, it requires a great deal of processing involving a combination of dry, wet, and proprietary separation processes. This raises the question of whether plastics have enough value to warrant the effort necessary to separate them by resin type, which will be answered by further research.

About half of the plastics in computers contain brominated flame-retardants. These halogenated substances can create both dioxins and furans during heat treatment that could occur in a smelting operation or in the extrusion process of plastic recycling. Preventing the formation of these compounds requires complete burning at a temperature of 1600 F° or higher, with a residence time of 2 seconds, with excess oxygen. Many recyclers choose to avoid plastics from electronic equipment due to the difficulty in identifying plastics containing flame-retardants.

## **Export**

The dumping of hazardous e-waste in China and other developing countries has garnered headlines across the globe. In many developing countries, discarded electronics are taken apart by hand under crude conditions without regard for proper environmental or worker safety

protections. This practice continues because customers go to “recyclers” who operate at the lowest cost.

You must know exactly what really happens to your end-of life electronics. Recyclers can claim to ship old computers overseas for reuse. Many times, the shipment will include good equipment and toxic junk along for the ride. Legitimate export will include a bill of lading itemizing each item, including make, model, and condition. As part of the recycling contract process, you can ask to see this documentation. If you are unsure of the value and quality of the collected equipment, it may be better to have it managed domestically.

Export of recycled commodity materials such as recycled glass and metals will be necessary if they are to be included in new products. Most electronic products are manufactured outside this country. Export of recycled metals and glass is necessary if these commodities are to be used in manufacture of new products.

Export of commodity materials as described above—when the exporter is paid a price for commodities—is not likely to result in the unsafe overseas recycling practices that have been highlighted by Basel Action Network. Still, a loss of control over the ultimate fate of materials when they leave this country is inevitable.

## ***Tracking E-Waste***

Once the e-waste leaves the collection site, the waste must be followed downstream to its end destination. The e-waste recycler is not the end destination. The e-waste received at the collection event may pass through a number of hands before reaching its final destination. The generator has responsibility to understand who will be handling the e-waste and what processing will be used from the time the waste leaves the collection site until it reaches the end market. The recycling contract is the vehicle to ensure that the recycler reports the final destination and fate of the electronic waste.

Remember that the generator’s jurisdiction has CERCLA (Superfund) liability for payment of cleanup of any site contaminated as a result of handling your hazardous wastes. The scrap metal industry was given hazardous waste liability protections as part of the Superfund Recycling Equity Act of 1999. This places local government in an even more vulnerable position regarding long-term liability if waste is mismanaged.

Due diligence is needed to ensure that all materials and components are properly recycled and disposed. Time and effort spent on tracking the waste from the collection site to its end destination will offer both liability and environmental protection. The paperwork audit trail will help to ensure that all materials and components are properly recycled and do not end up disposed illegally or shipped overseas to eventually become someone else’s waste nightmare.

The overall outcome of collecting e-waste and being prepared will lead to better utilization of precious resources and better public health and safety for your community.

# Bibliography

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- Analysis of Five Community Consumer/Residential Collections End-Of-Life Electronic and Electrical Equipment*, U.S. Environmental Protection Agency Region I, USEPA-901\_R-98-003, April 1999. <[www.epa.gov/region1/assistance/solid/csifinal.pdf](http://www.epa.gov/region1/assistance/solid/csifinal.pdf)>
- Cauchi, David, et al., *Recycling Used Electronics, Report on Minnesota's Demonstration Project*, July 2001. <[www.moea.state.mn.us/plugin/ElectronicsReport.pdf](http://www.moea.state.mn.us/plugin/ElectronicsReport.pdf)>
- Changes to California's Universal Waste Regulations—Fact Sheet*, California Department of Toxic Substances Control, March 2003. <[www.dtsc.ca.gov/HazardousWaste/Mercury/HWMP\\_FS\\_UWRChanges.pdf](http://www.dtsc.ca.gov/HazardousWaste/Mercury/HWMP_FS_UWRChanges.pdf)>
- Compliance Bulletin, Hazardous Waste Management of Electronic Waste*, Colorado Department of Public Health and Environment, revised June 2003. <[www.cdphe.state.co.us/hm/electronics.pdf](http://www.cdphe.state.co.us/hm/electronics.pdf)>
- Core Performance Elements of the Guidelines for Environmentally Sound Management of Wastes*, Working Group on Waste Prevention and Recycling, presented at the Third Workshop on Environmentally Sound Management of Wastes (ESM) Washington D.C., March 20–22, 2002. <[www.olis.oecd.org/olis/2001doc.nsf/LinkTo/env-epoc-wgwp\(2001\)4-rev3](http://www.olis.oecd.org/olis/2001doc.nsf/LinkTo/env-epoc-wgwp(2001)4-rev3)>
- Dann, Carolyn, *End-of-Life Electronic Equipment Pilot Collection Program Summary Report—Alachua County, Florida*, October 1999. <[www.dep.state.fl.us/waste/quick\\_topics/publications/shw/electronics/alach\\_99.pdf](http://www.dep.state.fl.us/waste/quick_topics/publications/shw/electronics/alach_99.pdf)>
- Davis, Sheila, “E-Waste Contracting Alternatives: Promoting Environmental and Economic Sustainability,” *The Monitor of Electronics Recycling Issues*, No. 3, Materials for the Future Foundation, June 2002.
- E-Waste How to Guide: Implementing an Effective Municipal Collection Using Best Practices, Draft - Version 2*, REAP2 (Recycling Electronics and Pollution Prevention) Municipal Consortium, January 13, 2003. <[www.co.oakland.mi.us/reap2/](http://www.co.oakland.mi.us/reap2/)>
- Electronics Recycler's Pledge of True Stewardship*, Silicon Valley Toxics Coalition and Basel Action Network, Report presented at the International Symposium on Electronics and the Environment (ISEE) and the Electronics Recycling Summit, May 6–9, 2002. <[www.ban.org/E-waste/Pledge/Electronics Recycler\\_pledge\\_signable.PDF](http://www.ban.org/E-waste/Pledge/Electronics%20Recycler_pledge_signable.PDF)>
- Electronics Recycling Online Data Form*, National Electronics Product Stewardship Initiative (NEPSI). <[www.ergweb.com/nepsi/default.html](http://www.ergweb.com/nepsi/default.html)>
- Electronic Product Recovery and Recycling Baseline Report: Recycling of Selected Electronic Products in the United States*, National Safety Council, May 1999. <[www.nsc.org/ehc/epr2/baseline.htm](http://www.nsc.org/ehc/epr2/baseline.htm)>
- End-of-Life Computer and Electronics Recovery Options for the Mid-Atlantic States, Second Edition*, Mid-Atlantic Consortium of Recycling and Economic Development Officials (MACREDO), March 2000. <[www.libertynet.org/macredo/comelec.htm](http://www.libertynet.org/macredo/comelec.htm)>
- Houghton, Robert, *The 3 Immutable Laws of eWaste Management, and Other Recycling Truths*, presented to the Federal Network for Sustainability, May 14, 2002. <[www.federalsustainability.org/initiatives/eps/Houghton FNS.ppt](http://www.federalsustainability.org/initiatives/eps/Houghton_FNS.ppt)>

- IAER Electronics Recycling Industry Report*, International Association of Electronics Recyclers, Inc., 2003.
- Jang, Yong-Chul, Timothy Townsend, et al., “RCRA Toxicity Characterization of Discarded Electronic Devices,” Department of Environmental Engineering Sciences, University of Florida, 2002. <[www.floridacenter.org/publications/lead\\_leachability\\_99-5.pdf](http://www.floridacenter.org/publications/lead_leachability_99-5.pdf)>
- Just Say No to E-Waste, Background Document on Hazardous And Waste From Computers*, Silicon Valley Toxics Coalition. <[www.svtc.org/cleancc/pubs/sayno.htm](http://www.svtc.org/cleancc/pubs/sayno.htm)>
- Loew, Sonja, *Pilot Checklists and Explanatory memorandum for evaluation of the Environmental Soundness of an Importing Facility—Management of the Waste Stream: Used Personal Computers*, presented at the second OECD Workshop on Environmentally Sound Management of Wastes Destined for Recovery Operations, September 28–29, 2000, Vienna, Austria. <[www.oecd.org/dataoecd/47/22/2742514.pdf](http://www.oecd.org/dataoecd/47/22/2742514.pdf)>
- Management of Waste Electronic Appliances*, Minnesota Office of Environmental Assistance, 1995. <[www.moea.state.mn.us/publications/wastelec.pdf](http://www.moea.state.mn.us/publications/wastelec.pdf)>
- Managing Electronic Equipment*, Minnesota Pollution Control Agency, Waste Fact Sheet #4.15, July 2002. <[www.pca.state.mn.us/publications/w-hw4-15.pdf](http://www.pca.state.mn.us/publications/w-hw4-15.pdf)>
- Managing Used Computers, A Guide for Businesses & Institutions*, Wisconsin Department of Natural Resources, 2000. PUB WA-42000. <[www.dnr.state.wi.us/org/aw/wm/publications/recycle/pubwa420.pdf](http://www.dnr.state.wi.us/org/aw/wm/publications/recycle/pubwa420.pdf)>
- Matthews, H. Scott, and Francis C. McMichael, et al., *Disposition and End-of-Life Options for Personal Computers*, Green Design Initiative Technical Report #97-10. Carnegie Mellon University, July 7, 1997. <[www.ce.cmu.edu/GreenDesign/comprec/NEWREPORT.PDF](http://www.ce.cmu.edu/GreenDesign/comprec/NEWREPORT.PDF)>
- Monchamp, Amanda, *The Evolution of Materials Used in Personal Computers*, Prepared by the Electronics Industry Alliance for the Second OECD Workshop on Environmentally Sound Management of Wastes Destined for Recovery Operations, Vienna, Austria, September 28–29, 2000. <[www.oecd.org/dataoecd/44/46/2741576.pdf](http://www.oecd.org/dataoecd/44/46/2741576.pdf)>
- Municipal Solid Waste in the United States, 2000 Facts and Figures*, EPA Office of Solid Waste and Emergency Response, EPA530-R-02-001, June 2002. <[www.setonresourcecenter.com/environmental/publications/RCRA/report-00.pdf](http://www.setonresourcecenter.com/environmental/publications/RCRA/report-00.pdf)>
- Nebraska Toolkit for Setting Up Electronics Recycling Programs—Section I*, Northeast Recycling Council, Inc., May 2003. <[www.nerc.org/adobe/NebraskaToolkitSection-I.pdf](http://www.nerc.org/adobe/NebraskaToolkitSection-I.pdf)>
- Nebraska Toolkit for Setting Up Electronics Recycling Programs—Section II, Guidance for Potential Electronics Recycling Entrepreneurs*, Northeast Recycling Council, Inc., May 2003. <[www.nerc.org/adobe/NebraskaToolkitSection-II.pdf](http://www.nerc.org/adobe/NebraskaToolkitSection-II.pdf)>
- Organizing a One-Day Computer Equipment Recycling Event, A Planning Guide*, Colorado Governor’s Office of Energy Management and Conservation, and EcoCycle, Inc., April 2002. <[www.ecocycle.org/documents/OrderForm\\_ComputerEvent.PDF](http://www.ecocycle.org/documents/OrderForm_ComputerEvent.PDF)>
- Parascandola, Christina Bechak, “Many Points of Law Open to Interpretation, Superfund Recycling Equity Act,” *American Metal Market, Metals Recycling Supplement*, March 22, 2001.

- Management of the Waste Stream, Used Personal Computers*, Federal Ministry for Agriculture, Forestry, Environment and Water Management, Second OECD Workshop on Environmentally Sound Management of Wastes Destined for Recovery Operations, Vienna, Austria, 28–29 September 2000.
- Pinellas County, Florida: Innovative Grant Reimbursement Program*, Pinellas County Department of Solid Waste Operations, 2000. <[www.dep.state.fl.us/waste/quick\\_topics/publications/shw/electronics/pinellas\\_00.pdf](http://www.dep.state.fl.us/waste/quick_topics/publications/shw/electronics/pinellas_00.pdf)>
- Poison PCs and Toxic TVs, California's Biggest Environmental Crisis You've Never Heard Of*, Californians Against Waste Foundation, Green Capital, Silicon Valley Toxics Coalition, Materials for the Future Foundation, 1999. <[www.svtc.org/cleancc/pubs/poisonpc.htm](http://www.svtc.org/cleancc/pubs/poisonpc.htm)>
- Porter, J.D., "Closing the circuit on electronics recycling," *Resource Recycling*, June 2000, pp. 22–27.
- Price, John L., *Reclaiming End-of-Life Cathode Ray Tubes (CRTs) and Electronics: A Florida Update*, Hazardous Materials Conference, Tucson, Arizona, November 15, 1999. <[www.nrc-recycle.org/resources/electronics/docs/fl-crt.pdf](http://www.nrc-recycle.org/resources/electronics/docs/fl-crt.pdf)>
- Recycling Used Electronics, Report on Minnesota's Demonstration Project*, Minnesota Office of Environmental Assistance, July 2001. <[www.moea.state.mn.us/plugin/ElectronicsReport.pdf](http://www.moea.state.mn.us/plugin/ElectronicsReport.pdf)>
- Remolador, Marry Ann, *Used Electronics Market Study Survey Analysis*, Northeast Recycling Council, Inc. (NERC), August 2003.
- Roman, Lauren, "Creating an electronics recycling program," *Waste Age*, Vol. 32, No. 2, February 2001. <[wasteage.com/mag/waste\\_creating\\_electronics\\_recycling/](http://wasteage.com/mag/waste_creating_electronics_recycling/)>.
- , *Globally Accepted Best Practices for Electronics Recycling*, presented at the IAER Electronics Recycling Summit, May 2003.
- , Preventative Medicine, *Recycling Today*, June 10, 2003, pp. 54–59. <[www.recyclingtoday.com/articles/article.asp?ID=4798&CatID=&SubCatID=/>](http://www.recyclingtoday.com/articles/article.asp?ID=4798&CatID=&SubCatID=/>)
- Safety & Health Guide for the Microelectronics Industry OSHA 3107*, U.S. Department of Labor Occupational Safety and Health Administration, 1988.
- Selected E-Waste Diversion in California, A Baseline Study*, California Integrated Waste Management Board, November 2001. <[www.ciwmb.ca.gov/Publications/default.asp?pubid=933](http://www.ciwmb.ca.gov/Publications/default.asp?pubid=933)>
- Setting Up & Operating Electronics Recycling/Reuse Programs, A Manual for Municipalities and Counties*, Northeast Recycling Council, Inc. (NERC), March 2002. <[www.nerc.org/adobe/survey/index.html](http://www.nerc.org/adobe/survey/index.html)>
- The Recycling and Demanufacturing of Computers and Electronic Equipment in Pasco County, Florida*, April 2000. <[www.dep.state.fl.us/waste/quick\\_topics/publications/shw/electronics/pasco\\_00.pdf](http://www.dep.state.fl.us/waste/quick_topics/publications/shw/electronics/pasco_00.pdf)>
- Tonetti, Robert, *Environmentally Sound Management of Used and Scrap Personal Computers*, Presented at the second OECD Workshop on Environmentally Sound Management of Wastes Destined for Recovery Operations, September 28–29, 2000, Vienna, Austria.



*Used TV & Computer Recycling & Management in Florida: A Resource Guide*, Southern Waste Information eXchange, Inc., SWIX, September 1999. <[www.wastexchange.org/publications/1999\\_09\\_TV\\_computer\\_recycling.pdf](http://www.wastexchange.org/publications/1999_09_TV_computer_recycling.pdf)>